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ABSTRACT

This study was undertaken as an effort to inform secondary school planners relative to the effects of the long block-of-time class period for fewer days on the achievement, retention and attitudes of pupils. The study was limited to six class groups enrolled for Biology I and six class groups enrolled for Plane and Solid Geometry at Cape Girardeau, Missouri, Central High School. Measurement of gains in cognitive learning achievement and in retention of achievement, sampling of pupil preferences and opinions, and sampling of teacher reaction were focused on this group. The study warranted the following generalizations and implications: (1) Secondary school administrators may infer that lengthened periods may be scheduled without the time factor being detrimental to pupil learning or retention; (2) Longer class periods may be adopted for geometry or biology to open up new possibilities for instruction; (3) Extended class periods will be acceptable to pupils, especially if classes are designed to include a variety of learning activities each day; (4) Similar studies should be made using different groups and situations. (WS)

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## FINAL REPORT

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# INVESTIGATION OF THE EFFECTS OF ALLOCATION OF INSTRUCTIONAL TIME ON PUPIL ACHIEVEMENT AND RETENTION

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May 1972

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INVESTIGATION INTO THE EFFECTS OF ALLOCATION OF INSTRUCTIONAL  
TIME ON PUPIL ACHIEVEMENT AND RETENTION

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Cape Girardeau, Missouri

May 15, 1972

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The movement toward the longer class period for secondary schools was given impetus in the early 1930's when the North Central Association of Colleges and Secondary Schools gave its endorsement to the long period plan. The Association included the long period schedule in a list of desirable trends in secondary education in a report issued in 1932. The report stated:

Commendable progress is being made in the adoption of the lengthened class period. This year 874 schools or over 36 per cent of the schools are operating with class periods of 55 or more minutes in length. Last year only 29 per cent of the schools were organized on the basis of a lengthened class period and five years ago the percentage was only 24.<sup>2</sup>

Even though the short period (forty to forty-five minutes) is still being used in some secondary schools, the long period schedule (fifty to sixty minutes) became the mode in secondary school scheduling during the years following World War II.<sup>3</sup>

During the 1960's new directions in secondary school philosophy and instructional methodology prompted another wave of innovation in the allocation of class time and the programming of the school day. Secondary schools have departed from traditional class schedules with increasing frequency. Most of these changes have been made in an attempt to provide an improved environment for instruction.

Many of these scheduling innovations have been subjectively related to the creation of an improved environment for achieving instructional objectives in the affective domain.<sup>4</sup> Surprisingly, little consideration has been given to the effects of such class time variations on learning in the cognitive domain.<sup>5</sup> If

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<sup>2</sup>"Proceedings of the Commission on Secondary Schools," North Central Association Quarterly, VII (June, 1932), p. 69.

<sup>3</sup>O. K. Garretson, "Statistical Summary of Annual Reports from Secondary Schools, 1945-46," North Central Association Quarterly, XXI (January, 1947), p. 350.

<sup>4</sup>David R. Krathwohl, Benjamin S. Bloom, and Bertram B. Masia, Taxonomy of Educational Objectives, Handbook II: Affective Domain, (New York: David McKay Company, Inc., 1964), p. 7.

<sup>5</sup>Benjamin S. Bloom (ed.), Taxonomy of Educational Objectives, Handbook I: Cognitive Domain, (New York: David McKay Company, Inc., 1956), p. 7.

cognitive learning provides the foundation for continued education, then the effects of scheduling changes on cognitive learning should not be overlooked by those responsible for making class schedules.

#### STATEMENT OF THE PROBLEM

Though conclusive survey data on the diffusion of innovative practices in secondary schools are scarce, some recent studies of innovation in education seem to support the assumption that secondary schools are departing from the traditional daily class schedule of six to eight, forty to sixty-minute class periods with increasing frequency.<sup>6</sup> A review of research fails to disclose any consistent findings about the effects different lengths of class periods have on pupil achievement. It appears that many secondary school administrators have been willing to change class time allotments without thoroughly investigating the possible effects such changes might have on pupil learning. It seems obvious that educators should have given high priority to consideration of pupil achievement when making decisions about changing the allocation of time to class schedules. Yet, there are not sufficient research data on the relationship between class time and pupil achievement to provide a sound basis for making such changes.

#### NEED FOR THE STUDY

Learning theorists have been interested in the relationship between time devoted to learning activities and learning achievement for the better part of the last one hundred years. Beginning as early as 1885, researchers have given periodic attention to the effects of such factors as time spent, attention span, fatigue, and boredom on learning outcomes. Still, today's educational practitioner has been left with little in the way of guiding research data to rely upon when faced with decisions about how to best allocate class time to the various courses in the secondary school schedule.

Most of the formal investigations into the relationship between class length and pupil achievement predated currently

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<sup>6</sup>Gordon Cawelti, New Directions in Instructional Practice, (Iowa Center for Research in School Administration Special Report 54, Iowa City, Iowa: The Iowa Center for Research in School Administration, University of Iowa, 1968), pp. 4 and 7; William M. Alexander and others, The Emergent Middle School (New York: Holt, Rinehart and Winston, 1969).

accepted instructional practices such as teaching by inductive method; teaching through investigation, inquiry, and guided discovery; and increased use of audio-visual media to aid instruction. The dearth of recent research into the relationship between achievement and time spent in learning activities has provided an insecure foundation for many of the innovations in scheduling secondary school classes which have become popular during the last decade. Still, many secondary school administrators appear to have been content to disrupt traditional scheduling plans strictly on the basis of a priori reasoning.

Some innovative class schedules currently being developed for high schools have extended blocks of class time to two or more consecutive hours in class. These lengthened class periods are intended to give students and teachers longer periods of uninterrupted time for laboratory investigations, library research, project work, individualization of learning programs, and variation of instructional activities. Little information is currently available to indicate whether or not these longer class periods do indeed contribute to the quantity or quality of learning.

Increased understanding of the effects these longer class periods have on learning outcomes is needed by secondary schools planning innovations in their class schedules.

#### PURPOSE OF THE STUDY

The purpose of this study was to contribute to the existing body of knowledge available to secondary school planners relative to the effects of the long block-of-time class period for fewer days on the achievement, retention, and attitudes of pupils.

This study considered the following specific questions:

1. Do high school pupils scheduled for full Carnegie Unit courses in biology and geometry in ninety, 110-minute class periods differ significantly in cognitive achievement from similar pupils scheduled for the same courses in one hundred and eighty, 55-minute class periods?
2. Do high school pupils scheduled for full Carnegie Unit courses in biology and geometry in ninety, 110-minute class periods differ significantly in retention of what they learn from similar pupils scheduled for the same courses in one hundred and eighty, 55-minute class periods?

3. Do high school pupils scheduled for full Carnegie Unit courses in biology and geometry in ninety, 110-minute class periods instead of one hundred and eighty, 55-minute class periods develop a preference for one kind of schedule over the other?

As corollaries to question 3, (A) What reasons do pupils give for preferring the ninety-day, 110-minute class period or (B) What reasons do pupils give for preferring the one hundred and eighty-day, 55-minute class period.

4. What adjustments in instructional methods must teachers make in order to successfully adapt the courses under study to ninety class periods of 110 minutes instead of one hundred and eighty class periods of 55 minutes?

#### SCOPE OF THE STUDY

This study was limited to six class groups enrolled for Biology I and six class groups enrolled for Plane and Solid Geometry at Cape Girardeau, Missouri, Central High School.

Measurement of gains in cognitive learning achievement, and retention of achievement, was limited to the class groups in the study.

Sampling of pupil preferences and opinions about the experimental schedule was limited to subjects in the experimental class groups.

Sampling of teacher reaction and opinion was limited to the four instructors who participated in the project.

#### LIMITATIONS OF THE STUDY

This study was limited by the validity and reliability of the instruments of evaluation which were used to measure cognitive learning achievement and retention in the courses selected for study.

The study was limited by the degree to which teachers were able to equate their methods of instruction within the two time variables under study.

The generalizability of any finding or conclusions of this study was limited to similar populations and samples.

#### HYPOTHESES

The following hypotheses were tested in this study:

1. That high school pupils in biology meeting in daily classes of 110 minutes for ninety days would not differ significantly in cognitive learning achievement from similar pupils in biology meeting in daily classes of 55 minutes for one hundred and eighty days.
2. That high school pupils in geometry meeting in daily classes of 110 minutes for ninety days would not differ significantly in cognitive learning achievement from similar pupils in geometry meeting in daily classes of 55 minutes for one hundred and eighty days.
3. That eight months following completion of the course, high school pupils in biology who had met in daily classes of 110 minutes for ninety days would not differ significantly in retention from similar pupils in biology who had met in daily classes of 55 minutes for one hundred and eighty days.
4. That eight months following completion of the course, high school pupils in geometry who had met in daily classes of 110 minutes for ninety days would not differ significantly in retention from similar pupils in geometry who had met in daily classes of 55 minutes for one hundred and eighty days.
5. That among high school pupils completing biology or geometry in classes meeting 110 minutes daily for ninety days:
  - A. There would be no significant difference between the total numbers of pupils preferring one class time allocation over the other.
  - B. There would be no significant difference between the scheduling preferences of pupils taking the same subjects with different teachers.
  - C. There would be no significant difference between the scheduling preferences of pupils taking biology and those taking geometry.



D. There would be no significant difference between the scheduling preferences of pupils enrolled in long-block-of-time classes for the first time (first semester) and those enrolled in this kind of class for a second time (second semester).

#### DEFINITION OF TERMS

As used in this study, the following definitions apply.

Biology: The first course in high school biology taught by the BSCS High School Biology: Green Version approach.

Biology Achievement: The gain in posttest over pretest score as measured by the BSCS Green Version High School Biology Comprehensive Final Examination: Form L.<sup>7</sup>

Carnegie Unit: A standard of measurement for describing the secondary school subject matter pattern as originally defined by the Carnegie Foundation for the Advancement of Teaching. Assuming sixteen units of work in a four-year secondary school pattern, the Carnegie Unit represents a year's study in any subject of not less than 120 sixty-minute class hours or their equivalent.<sup>8</sup>

Cognitive Learning Achievement: Growth in learning within the cognitive domain as defined by Benjamin S. Bloom and his associates.<sup>9</sup> The cognitive domain includes the behaviors of remembering, reasoning, problem solving, concept formation, and to a limited extent, creative thinking.

Control Group or Control Class: Those groups or classes enrolled for biology or geometry taught in fifty-five minute periods for 180 days and not associated with the experimental treatment.

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<sup>7</sup>William B. Miller and Carol Leth (eds.), BSCS Green Version High School Biology Comprehensive Final Examination: Form L (2d ed.; Chicago: Rand McNally & Company, 1970).

<sup>8</sup>Carter V. Good (ed.), Dictionary of Education (New York: McGraw-Hill Book Company, Inc., 1959), p. 587.

<sup>9</sup>Bloom, loc. cit.

Experimental Group or Experimental Class: Those groups or classes enrolled for biology or geometry taught in one hundred and ten minute class periods for 90 days.

Geometry: The full unit high school course in Plane and Solid Geometry taught using Concepts in Modern Mathematics, Book II.<sup>10</sup>

Geometry Achievement: The gain in posttest over pretest score as measured by the Howell Geometry Test.<sup>11</sup>

Long Block-of-Time Period: A class period scheduled to meet one hundred and ten minutes daily for 90 days.

Traditional Class Period: A class period scheduled to meet fifty-five minutes daily for 180 days.

#### SUMMARY

The purposes of this study were: (A) to determine whether the distribution of class time in 110-minute periods for ninety days, instead of 55-minute periods for one hundred and eighty days, had any effect on cognitive learning achievement of pupils; (B) to determine whether the allocation of class time in 110-minute periods for ninety days, instead of 55-minute periods for one hundred and eighty days, had any effect on the pupils' retention of learning; (C) to determine whether students having experienced instruction under the ninety-day, 110-minute class period did or did not prefer this allocation of class time over the traditional 55-minute, one hundred and eighty day class period, and the reasons for their preferences; and (D) to determine what adjustments in instructional method teachers found necessary in order to use the long-block-of-time class period successfully.

This chapter also sets forth the need for the study, the scope and limitations of the study, the hypotheses to be tested, and the definition of terms used.

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<sup>10</sup>Morton R. Kenner, Dwain E. Small, and Grace N. Williams, Concepts of Modern Mathematics, Book II (New York: American Book Company, 1963).

<sup>11</sup>Edgar N. Howell, Howell Geometry Test (New York: Harcourt, Brace and World, Inc., 1969).

## CHAPTER II

### REVIEW OF RELATED LITERATURE

During the past ten years, modification of the traditional secondary school class schedule has become a popular educational innovation. Cawelti's study revealed that 838, or 14.8 percent of the responding schools, had tried some modification of their class schedule which could be described as a "flexible schedule."<sup>1</sup> Although Cawelti reported a rather high rate of abandonment for several educational innovations, the rate of abandonment for flexible schedules was a relatively low 7.3% among schools which had tried one.<sup>2</sup> The professional literature of the 1960's contains numerous articles describing and extolling various kinds of flexible schedules.

A perusal of the educational journals shows these reports of scheduling innovations to be mostly descriptions of what has been done. Many include subjective accounts of the successes for these programs. Very few report objective data on the results of these innovations. Reported research on the effects of class time modifications on pupil learning or attitudes is virtually nonexistent.

The first purpose of this chapter shall be to review the literature for theoretical or scientific bases which support the traditional practice of allocating forty to sixty minutes to secondary school class periods. The second purpose shall be to present a brief review of several field studies which have investigated the effects of various allocations of class time on the achievement and attitudes of pupils in the scholastic setting.

#### TEMPORAL LIMITS TO LEARNING ACTIVITY: THEORETICAL CONSIDERATIONS

Carroll developed a model for school learning which conceived five elements that determine the quality and quantity of learning.

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<sup>1</sup>Gordon Cawelti, "Innovative Practices in High Schools: Who Does What--and Why--and How," Nations Schools, LXXIX (April, 1967), pp. 61-63.

<sup>2</sup>Ibid., pp. 64-66.

Three of these elements reside in the learner. Two elements are environmental. Those factors in the learner are: (1) aptitude--the time needed by the learner to accomplish a learning task, (2) ability--the capacity of the learner to understand the instruction, and (3) perseverance--the amount of time a learner can and will engage actively in a learning activity. The external factors are: (4) opportunity--the time allowed for learning, and (5) quality--the ability of the teacher to provide suitable instruction.<sup>3</sup> Carroll contends that if ability and quality are held constant, and if the time available for learning is unrestricted, then the degree of learning becomes a function of the learner's perseverance compared to his aptitude. He expressed this theory in a formula.<sup>4</sup>

$$\text{Degree of Learning} = f\left(\frac{\text{Perseverance}}{\text{Aptitude}}\right)$$

In other words, the quality and quantity of learning are determined by how long a learner can stay with the learning task compared to the speed with which he learns.

A learner's ability and willingness to persevere at a learning task is believed by many to be limited by a state called "mental fatigue." What are the viable limits to a learning activity as a result of "mental fatigue"?

Most studies of the effects of mental fatigue are founded on Hull's Theory of Reactive Inhibition.<sup>5</sup> Hull's postulates have been supported by research with both animal and human subjects conducted by Pavlov, Switzer, Hovland, Calvin, Mower, and others. However, Hull's writings reveal that while he and his associates have been able to estimate the cumulative effects of physical fatigue and recovery, the effects of loss of motivation due to "mental fatigue" have defied precise definition.<sup>6</sup> In fact, most behavioral scientists have now come to doubt the existence of "mental fatigue" in the sense that physical fatigue is known to exist.

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<sup>3</sup>John B. Carroll, "A Model of School Learning," Teachers College Record, LXIV (May, 1963), pp. 723-33.

<sup>4</sup>Ibid., p. 730.

<sup>5</sup>Clark L. Hull, Principles of Behavior (New York: Appleton-Century Company, 1943). pp. 277-303.

<sup>6</sup>Clark L. Hull, A Behavior System (New Haven, Connecticut: Yale University Press, 1952), p. 9.

Thorndike concluded that in tasks which were almost entirely mental--that is, where almost no physical adjustment was involved--experimental subjects could remain at these tasks for as long as four hours at a time without any noticeable drop in efficiency or output.<sup>7</sup>

Arai found that even in severe mental tasks such as continuous work at solving mathematical problems, some subjects could sustain their effort as long as twelve hours a day for several days before a significant drop in efficiency was observed to occur.<sup>8</sup>

More recent studies of learning achievement under conditions of massed practice and spaced practice have continued to support the findings of these early investigations. The success of the American Armed Forces with concentrated crash programs in foreign languages<sup>9</sup> and basic education for illiterate inductees<sup>10</sup> during World War II produced strong evidence that adult learners can learn under conditions of massed instruction when motivation is high.

As the school curriculum of the 1960's shifted from emphasis on rote learning to emphasis on understanding, it was found that learning of concepts, as well as learning of facts, could be accomplished efficiently under conditions of massed practice. A recent study at the University of Miami (Florida) found that undergraduate subjects learned concepts most effectively under massed practice and mediation conditions and least effectively under conditions of distributed practice and mediation.<sup>11</sup>

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<sup>7</sup>E. L. Thorndike, "Mental Fatigue," Journal of Educational Psychology, II (1911), pp. 51-80.

<sup>8</sup>Tsuru Arai, Mental Fatigue, Teachers College Contributions to Education Number 54 (New York: Bureau of Publications, Teachers College, Columbia University, 1912).

<sup>9</sup>Commission on Trends in Education, A Survey of Language Classes in the Army Specialized Training Program (New York: The Modern Language Association of America, 1944).

<sup>10</sup>Samuel Goldberg, Army Training of Illiterates in World War II, Teachers College Contributions to Education Number 966 (New York: Bureau of Publications, Teachers College, Columbia University, 1951).

<sup>11</sup>Jim Millham, Leonard I. Jacobson, and Stephen E. Berger, "Effects of Intelligence, Information Processing, and Mediation Conditions on Conceptual Learning," Journal of Educational Psychology, LXII (August, 1971), pp. 293-99.

The research reported in the preceding studies would indicate that the phenomenon we call "mental fatigue" is not really fatigue in any physiological sense. It appears that Hull's Theory of Reactive Inhibition cannot be applied to mental activity as it can be applied to physical activity.

Most authorities on human learning now believe that a pupil's ability to persevere at a learning task is a function of interest or motivation rather than fatigue. Bigge and Hunt have summarized this point of view by stating:

Attention span is obviously a function of motivation. . . . Fatigue does not seriously interfere with learning provided sufficient motivation is present. Conversely, in the absence of motivation a rather simple learning task can produce marked feelings of ennui.

It is misleading to say that attention span of children increases with age . . . it increases with motivation. The difference between childhood and adulthood appears to be that adults are better able to subordinate short-run pleasures in the interest of long-range pleasures. . . . Hence, they can more easily develop motivation for long-range learning tasks which require massed practice.<sup>12</sup>

Bugelski agreed that the degree of learning declines after a period of time at a learning task as a result of boredom and loss of interest.

There is a limit to the amount of effective practice at any one time. . . . Beyond this point efficiency is curtailed. . . . Sustained effort beyond that point is a waste of time. . . . Learning becomes distasteful and learners actually seek to avoid learning.<sup>13</sup>

Elsewhere, Bugelski wrote:

There are no general rules for identifying time limits for either work or rest. . . . We are limited to laboratory results that in general show a greater efficiency in learning when practice is spaced rather than massed.

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<sup>12</sup>Morris L. Bigge and Maurice P. Hunt, Psychological Foundations of Education (New York: Harper and Row, 1962), p. 380.

<sup>13</sup>B. R. Bugelski, The Psychology of Learning Applied to Teaching (New York: The Bobbs-Merrill Company, Inc., 1964), p. 82.

In general, practice periods should be only as long as they are productive. Rest or relaxation are necessary but they should also be no longer than necessary. . . .

At present there is no meaningful data that can be applied to all situations. About all of which we can be reasonably sure is that the fifty minute hour [period] is probably not an appropriate time for any learning activity.<sup>14</sup>

Skinner concurred with Bugelski's statement.

The periods into which the school day is broken measure the limits of aversive control rather than the capacity for sustained attention. The child will spend hours absorbed in play or watching movies or television who cannot sit still in school for five minutes before escape becomes too strong to be denied.<sup>15</sup>

Apparently, there is no research to support the existence of the state of "mental fatigue" comparable to the state of physical fatigue. There do appear to be limits to the amount of sustained practice a learner will endure without a break in the activity. However, this limit appears to be a function of motivation and not fatigue. No theoretical basis or scientific basis exists at this time to support the practice of scheduling the secondary school day in periods of forty to sixty minutes for instruction.

#### TEMPORAL LIMITS TO LEARNING ACTIVITY: PRACTICAL CONSIDERATIONS

A review of the literature reveals that studies of the relationship between classtime allocation and learning can be divided roughly into three eras, research in each era having been stimulated by new educational practices.

The first era roughly included the 1920's and 1930's and was stimulated by the movement from the forty or forty-five minute short period toward the long period of fifty to sixty-five minutes.

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<sup>14</sup>Ibid.

<sup>15</sup>B. F. Skinner, The Technology of Teaching (New York: Appleton-Century-Crofts, 1968), p. 97.



The second era occurred in the 1940's and 1950's as a result of the popularity of the core curriculum movement which sought to correlate or integrate course content across subject matter lines. This practice, which became particularly common in the junior high school, normally scheduled core classes in multiple period blocks of time.

The final era, beginning about 1960 and continuing to the present time, seems to have been motivated by two trends in education. The first has been the movement toward flexible scheduling of classes in variable time blocks. The second has been the rapid growth of vocational education in the secondary school stimulated by P.L. 88-210, The Vocational Education Act of 1963.

#### Research on the Long-Period Class

The long period of fifty minutes or more grew in popularity during the 1920's and 1930's. By the 1935-36 school term Clevenger's survey detected three trends in secondary school scheduling: (1) to adopt the hour period, (2) to adopt periods longer than forty-five minutes but shorter than sixty minutes, and (3) in a limited number of schools to go to periods longer than sixty minutes.<sup>16</sup> Proponents of the long-period schedule claimed it produced financial savings by eliminating double periods for laboratory classes, gave teachers better control of the learning situation by reducing large study halls and increasing inclass supervised study, provided much needed time for shop, laboratory, and physical education classes, provided opportunities to individualize instruction, gave teachers fewer classes and a less demanding schedule, and simplified schedule making.<sup>17</sup>

As a result of this trend several studies were made of the effects of the long-period schedule on achievement, and on the attitudes of pupils and teachers toward the long-period plan.

Stewart studied the achievement of high school pupils in class periods of forty minutes, eighty minutes, and one hundred and ten minutes. He studied both the effects of longer periods and greater total time spent in class, and the effects of longer periods with equal total time spent in class. Stewart found that achievement was higher for pupils who spent the longer total time in class.

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<sup>16</sup>A. W. Clevenger, "The Long-Period Daily Class Schedule for High Schools," North Central Association Quarterly, X (April, 1936), p. 457.

<sup>17</sup>Ibid., pp. 458-59.



more time in the two-hour class, materials had to be assembled twice a year instead of once, and the irregularity of a five-minute break given to pupils in the two-hour class disturbed other classes in session.<sup>21</sup>

In two extensive studies, Denman and Kirby found the learning achievement of pupils in schools using long class periods of fifty-five to sixty-four minutes was superior to that of pupils in schools using short periods of forty to forty-five minutes.

In their first study, results on the Iowa Academic Meet United States History Test were significantly higher for pupils from twenty-three high schools using long periods than for pupils from fifteen schools using short periods.<sup>22</sup>

A second study conducted by Denman and Kirby compared academic achievement of pupils from sixteen long-period high schools with pupils from sixteen short-period high schools using standardized achievement tests to measure achievement in nine academic areas. In six of the nine areas evaluated, long-period pupils showed achievement levels which were significantly greater than those of pupils from short-period schools.<sup>23</sup>

It should be noted that the total amount of time spent in class by pupils in the Denman and Kirby studies was not equal. Pupils in long-period schools received many more minutes of inclass instruction than pupils in short-period schools. Furthermore, no attempt was made by the investigators to control other potentially influential variables that might have affected pupil achievement.

In a study involving college freshmen at Iowa State Teachers College, Paul found that pupils taking courses in English, geography, psychology, and history of education in fifty-five minute classes achieved more than pupils taking these courses in thirty-minute classes.<sup>24</sup>

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<sup>21</sup>Ibid.

<sup>22</sup>George E. Denman and Thomas J. Kirby, "The Length of Class Period and Pupil Achievement," The School Review, XLI (April, 1933), p. 285.

<sup>23</sup>Ibid., pp. 285-89.

<sup>24</sup>J. B. Paul, "A Study of the Relative Effectiveness for Learning on the College Level of a Fifty-five and a Thirty-Minute Class Period," (unpublished Doctoral dissertation, University of Wisconsin, 1931).

Koos and Troxel, in a three-year study in Minneapolis high schools, found that teachers in long-period classes allowed more supervised study time for pupils and that they used more learning activities and distributed class time in more different ways. However, they found that teachers used essentially the same teaching methods in both long-period and short-period classes. They concluded that while longer periods offered greater opportunity for desirable improvements in methods of instruction, they were not being used maximally.<sup>25</sup>

More recently, Weber studied the effects of time spent in class and the length of class periods on English achievement. In this carefully controlled study, the achievement of experimental groups meeting for tenth grade English classes in five, forty-minute periods per week, and in two, one hundred and ten-minute periods per week was compared with a control group meeting five times per week in fifty-five minute periods. Achievement was greatest in the forty-minute class and was smallest in the one hundred and ten-minute class. However, no differences were found to be significant at the .05 level of confidence.<sup>26</sup>

Jarvis found that when sixth grade pupils in different schools were given periods of instruction which differed in length, those receiving the longer periods of instruction did achieve more in some subjects. Significant differences in arithmetic reasoning and arithmetic fundamentals were found to favor pupils who had spent fifty-five to sixty minutes daily studying arithmetic over pupils who had arithmetic periods of forty-five minutes or less. Achievement in language mechanics also was significantly greater for pupils who had spent longer periods in receiving instruction. However, no significant differences were found in reading vocabulary achievement between students taught reading sixty to seventy-eight minutes per day and those in reading classes of forty to fifty minutes in length. No consistent findings were reported for achievement of the two groups in reading comprehension. Jarvis

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<sup>25</sup>Leonard V. Koos and Cliver L. Troxel, "A Comparison of Teaching Procedures in Short and Long Class Periods," The School Review, XXXV (May, 1927), pp. 340-53.

<sup>26</sup>Charles Lewis Weber, "A Comparative Study of the Effects of Time Spent in Class, and Length of Class Time on Student Achievement in Sophomore English," (unpublished Doctoral dissertation, Oklahoma State University, 1966).

concluded that longer periods resulted in less improvement in reading than in language or arithmetic because reading was learned in other classes.<sup>27</sup>

Research on the effects of time spent in class on achievement of pupils has generally indicated that longer total class time does increase achievement. However, the length of class period has not been shown to have an effect on achievement, within the limits of these studies, provided the total amount of time spent in class is the same.

#### Research on the Multiple-Period Core Curriculum Class

The core curriculum plan of organization, which emphasized the correlation or integration of content across course lines, began to be accepted by educators during the 1930's. However, its rapid growth in practice occurred during the years following World War II.

A 1943 survey of core curriculum programs and block-of-time schedules by the Elizabeth, New Jersey, Public Schools revealed only limited acceptance of this plan of organization.<sup>28</sup> However, by 1954, Gruhn cited core-type programs scheduled in multiple-period blocks of time as the most prominent of several new developments in secondary education.<sup>29</sup>

Surveys conducted by Wright<sup>30</sup> and Bossing<sup>31</sup> during the middle 1950's confirmed that the multiple-period block-of-time

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<sup>27</sup>Oscar T. Jarvis, Time Allotments and Pupil Achievement in the Intermediate Elementary Grades, University of Houston Research Study Number 8 (Houston, Texas: Bureau of Education Research and Services, 1962).

<sup>28</sup>"Time Use in the Junior High School Program," Bulletin of the National Association of Secondary School Principals, XXIX (April, 1945), pp. 93-101.

<sup>29</sup>William T. Gruhn, "Some Significant Developments in Junior High School Education," Bulletin of the National Association of Secondary School Principals, XXXVIII (April, 1954), pp. 340-47.

<sup>30</sup>Grace S. Wright, Block-Time Classes and the Core Program in the Junior High School, Bulletin 1958, Number 6, United States Department of Health, Education and Welfare (Washington: Government Printing Office, 1958).

<sup>31</sup>Nelson L. Bossing, "Development of the Core Curriculum in the Senior High School," The School Review, LIV (May, 1956), pp. 224-26.

class combined with core curriculum organization of course content had become a well established practice, especially in the junior high school. English and social studies were the courses found most often to be unified.

Even though core curriculum plans became widely accepted in practice, few formal investigations were published which were concerned with the effects of such plans on the achievement of pupils.

The educational literature of the late 1950's contains frequent references to a study by Mennes. This three-year study was conducted in three Wisconsin high schools between 1947 and 1950 but results were not published until 1955 and 1956. Mennes's study compared the achievement of tenth grade pupils taking English and world history in a unified, double-period class with that of matched pupils taking these courses in conventionally taught single-period classes. Mennes found that the gain scores made by the experimental groups were greater than those of control groups in nineteen of the twenty-nine comparisons made.<sup>32</sup>

Mennes also found that ninety-two percent of the parents of students in the core program favored the double-period, unified-content plan.<sup>33</sup>

Other studies, not concerned with academic achievement, have consistently reported that pupils and teachers generally favored the multiple-period, unified-content approach. A survey of pupils in Wisconsin high schools using core-type course organization found that eighty-seven percent stated they liked the arrangement. This survey also found that teachers generally liked this practice, especially in larger schools, because it helped them establish a closer relationship with pupils.<sup>34</sup>

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<sup>32</sup>Arthur H. Mennes, "The Effectiveness of Multiple Period Curricular Practices in High School English and Social Studies," Journal of Educational Research, L (September, 1956), pp. 59-69.

<sup>33</sup>Arthur H. Mennes, "What Parents Think of the Multiple Period," Clearing House, XXIX (January, 1955), pp. 280-83.

<sup>34</sup>Edward A. Krug, Clifford S. Liddle, and Quentin F. Schenk, "Multiple Period Classes in Wisconsin," Bulletin of the National Association of Secondary School Principals, XXXVIII (October, 1954), pp. 79-83.

An earlier study by Greenley also reported that pupils preferred the double-period, unified-content plan. While no achievement testing was done in Greenley's study, teachers expressed the belief that pupils learned more under this plan. Specifically, teachers stated the multiple period improved pupils' study habits, that pupils got more work done, that it increased the rate at which pupils absorbed subject matter, and that it increased the permanence of learning. Teachers also said that the longer period enabled them to plan more intelligently and to better meet the needs of their pupils.<sup>35</sup>

Data on the effects of core curriculum and extended periods on pupil achievement are scarce. The limited reports available generally concluded that pupils learned as much, or more, under the core curriculum plan than they did under the traditional single subject plan of organization. These studies also were consistent in stating that a majority of parents, teachers, and pupils reacted favorably to core-type programs and extended class periods.

#### Research on Flexible Scheduling Plans

The term "flexible scheduling" is descriptive of several different scheduling practices. Among these are modular schedules where two or more short periods, or modules, are combined to create class periods of varying lengths. The variable modular schedule is a modification of the modular schedule which varies the lengths of class periods on different days of the week or on daily demand. The floating period, where one period moves through the daily schedule in some established sequence, and the double period or extended period are other kinds of flexible scheduling plans.<sup>36</sup>

Several recent studies have been made of pupil achievement in the flexibly scheduled program. Conclusions about the relationship between achievement and flexible schedules must be made with caution. Most flexible scheduling plans include other variables such as team teaching, independent study, or different modes of instruction, any one of which has the potential to influence pupil achievement. Attributing achievement differences to the flexible time allotment, alone, is a risky practice.

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<sup>35</sup>Kenneth F. Greenley, "Single Periods vs. Double Periods," The School Executive, LXIII (December, 1943), pp. 34-35.

<sup>36</sup>J. Lloyd Trump, "Flexible Class Schedules," California Journal of Secondary Education, XXXV (February, 1960), pp. 94-95.

One of the earliest studies of the effects of modular scheduling on pupil achievement was conducted by Speckhard in 1965 using two schools, one traditionally scheduled and one modularly scheduled, in the Boulder Valley, Colorado, School District. Using the Iowa Tests of Educational Development as the criterion measures, Speckhard found the achievement of sophomore students in the modularly scheduled school to be significantly superior to the achievement of sophomores in the traditionally scheduled school on six of the nine ITED subtests. However, only one significant difference in achievement was found between juniors in these schools, that one favoring students in the control school.

Speckhard did find that after one year, pupils in the modular schedule scored significantly higher than those in the traditional schedule on critical thinking as measured by the Watson-Glaser Critical Thinking Appraisal. No significant difference between groups was reported for study habits and attitudes as measured by the Brown-Holtzman Survey of Study Habits and Attitudes.<sup>37</sup>

Speckhard, in collaboration with Bracht, followed his initial study at Boulder Valley with a follow-up study in 1968. Data were obtained in the follow-up study from seniors who had been sophomores at the time of the initial study, thus enabling an assessment of the long-term effects of the modular schedule on achievement.

In the follow-up study experimental school pupils scored significantly higher than control school pupils on three of the nine ITED subtests with no significant differences found on the other six subtests. The second study also found no significant differences between the two pupil groups on critical thinking or in study habits and attitudes.<sup>38</sup>

Speckhard and Bracht concluded that modularly scheduled pupils achieved as well as, if not better than, pupils in traditional schedules. They also reported that both pupils and teachers in the

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<sup>37</sup>Gerald P. Speckhard, "An Evaluation of the Education Program of a High School Using a Modular Schedule," (unpublished Doctoral dissertation, University of Colorado, 1966). Available on microfilm from University Microfilms, Ann Arbor, Michigan. Permission to cite secured.

<sup>38</sup>Gerald P. Speckhard and Glenn H. Bracht, "An Evaluation of the Educational Program of a High School Using a Modular Schedule: A Follow-Up Study," Report Number RP-19, (Boulder, Colorado: Colorado University Laboratory of Educational Research, September, 1968). Available from Educational Research Information Center, ERIC Document Number ED 025 840. Permission to cite secured.



experimental high school held more favorable opinions of their school and its program. They reported, however, that neither teachers nor pupils had learned to use effectively the opportunities available to them under the modular schedule.<sup>39</sup>

The results of a study by Johnson at the University of Minnesota agreed in part with the findings reported by Speckhard and Bracht. Johnson found that the flexible modular schedule resulted in no significant differences among pupils in academic achievement as measured by the ITED, or in study habits and attitudes as indicated by the Brown-Holtzman Survey of Study Habits and Attitudes.<sup>40</sup>

Moore's study at the University of Iowa reported no significant differences in biology achievement between pupils in a modularly scheduled program and those in a traditionally scheduled program. As in other studies, Moore's study did not report any finding of differences in study habits or attitudes.<sup>41</sup>

Georgiades and Bjelke found that ninth grade English pupils in a three-period, interdisciplinary instructional program including algebra, social studies, and English, did achieve significantly better than English pupils taught in intact, conventionally scheduled classes. Significant differences favoring the team-taught groups were found in reading comprehension and on a teacher constructed test based on predetermined course objectives for English. No differences were found between groups in reading vocabulary.<sup>42</sup>

Blume reported that general academic achievement scores on the Sequential Tests of Educational Progress were higher in a

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<sup>39</sup>Ibid., pp. 32-33.

<sup>40</sup>George Bernard Johnson, "A Comparative Evaluation of the Flexible Modular Schedule at Harding High School, St. Paul, Minnesota," Dissertation Abstracts International, XXXI (April, 1971), p. 5078-A.

<sup>41</sup>Billy Fulton Moore, "The Effect of Flexible Modular Scheduling on Student Achievement in BSCS Biology," Dissertation Abstracts International, XXXI (March, 1971), p. 4387-A.

<sup>42</sup>William Georgiades and Joan Bjelke, "Evaluation of English Achievement in a Ninth Grade, Three-Period, Team-Teaching Class," California Journal of Educational Research, XVII (May, 1966), pp. 100-12.

modularly scheduled high school than they were for the same school during the three years preceding the scheduling innovations.<sup>43</sup>

A study by Klausmeier and Wiersma of pupil achievement in English and social studies at the junior high school level reported only one significant difference in achievement among several comparisons which were made. It was found that the achievement of low ability pupils in English taught by a three-teacher team in a multiple-period block-of-time class was greater than the achievement of paired counterparts taught in traditional one-teacher, single-period classes. No differences were found between average ability English pupils in the study. Neither the low ability nor average ability experimental and control groups were found to differ significantly in social studies achievement.<sup>44</sup>

Pupils in flexibly scheduled schools generally express favorable opinions of this kind of program. Of the studies cited, above, only the Johnson study reported a high frequency of pupil dissatisfaction with the modular schedule. While the majority of Johnson's pupil respondents were generally satisfied with the program, it was found that failure and dropout rates increased under the flexible modular scheduling plan, and that pupils, generally, held a negative attitude toward school. Their negative attitudes were primarily directed toward the independent study feature of the schedule.<sup>45</sup>

In addition to the studies previously cited, Forr and Yerkes,<sup>46</sup> and Johnson and Lobb<sup>47</sup> reported highly favorable pupil attitudes toward flexible modular scheduling plans in the schools they studied.

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<sup>43</sup>Donald Blume, "Modular Schedule at a Two-Year High School," Business Education Forum, XXV (May, 1971), pp. 21-22.

<sup>44</sup>Herbert J. Klausmeier and William Wiersma, "Team Teaching and Achievement," Education, LXXXVI (December, 1965), pp. 238-42.

<sup>45</sup>Johnson, loc. cit.

<sup>46</sup>William A. Forr and Lester M. Yerkes, "Modulizing Distributive Education," Business Education Forum, XXV (May, 1971), pp. 22-23.

<sup>47</sup>Robert H. Johnson and M. Delbert Lobb, "Jefferson County, Colorado, Completes a Three-Year Study of Staffing, Changing Class Size, Programming, and Scheduling," Bulletin of the National Association of Secondary School Principals, XLV (January, 1961), pp. 57-78.



In all studies of flexible modular scheduling previously cited, both teachers and parents were reported to hold generally favorable opinions of the flexible scheduling plans in their schools.

In 1968 Cawelti surveyed eleven flexibly scheduled high schools to see if scheduling innovations did make a difference in pupil attitudes, teacher morale, and organizational climate. Eleven control schools with traditional schedules were paired with eleven innovative schools on the variables of locality, per pupil expenditure, and pupil/teacher ratio. The experimental and control schools were compared on responses to questionnaires administered to both teachers and pupils. As a result of the survey Cawelti reported these conclusions relative to teacher morale and occupational climate: (1) teachers in innovative schools perceived themselves as more involved in policy making, (2) they were more receptive to suggestions from super-ordinates, but (3) no significant differences were found to exist between innovative and traditional schools in ratings of teacher morale.<sup>48</sup>

In regard to pupil attitudes Cawelti reported that pupils in innovative high schools felt less regimented and that they thought they had more opportunity to participate in making changes in the school. However, the study found no significant differences between pupils in innovative and traditional schools in their attitudes toward school, the amount of individualized instruction they thought they received, the relevance of their subjects, or their respect for scholarship. In both types of schools the attitudes expressed by the pupils were predominantly negative.<sup>49</sup>

Cawelti stated in regard to the effects of scheduling innovations on academic achievement:

Although not part of the research design, the comparison of data suggests that student growth in academic achievement is at least as good and often better when students are given increased measures of freedom within the school day.<sup>50</sup>

The findings reported by Cawelti adequately summarize the general findings of other studies of the effects of flexible scheduling plans on pupil achievement and the attitudes of pupils and teachers. There is general agreement among most studies that

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<sup>48</sup>Gordon Cawelti, "Does Innovation Make Any Difference?", Nation's Schools, LXXXII (November, 1968), p. 61.

<sup>49</sup>Ibid.

<sup>50</sup>Ibid., p. 63.

pupils attending classes under flexible scheduling plans achieve as well as, if not better than, pupils attending classes under traditional class schedules. In general, the attitudes of both pupils and teachers toward their school programs seem to be more favorable in flexibly scheduled schools than in traditionally scheduled schools.

#### Research on Multiple-Period Vocational Education Classes

The multiple-period block-of-time class has been common in scheduling vocational education programs for several years. The rationale for this practice has been that extended periods enable courses to more closely simulate on-the-job conditions as pupils approach their initial full-time employment. Still, vocational educators have shown interest in finding an optimal length for these courses.

Rosin reported that vocational welding pupils enrolled in two-hour classes each day performed as well on a test of welding information and skills as pupils taught in welding classes meeting three hours each day.<sup>51</sup>

In a doctoral study at the University of North Dakota typing pupils in traditional class periods were found to be superior in straight-copy timed writings and production typing to pupils who spent shorter periods in class group instruction supplemented by independent study under a modular scheduling plan.<sup>52</sup>

An extensive study was initiated in 1969 which should, upon completion, provide business educators with some scientifically established guidelines for allocating classtime to business education classes. This study, coordinated by the Michigan State University Research and Development Program in Vocational Office

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<sup>51</sup>John W. Rosin, "A Comparison of Student Achievement Between Two- and Three-Hour Public School Trade and Industrial Educational Welding Classes," (unpublished Doctoral dissertation, Texas A and M University, 1969). Also available from Educational Research Information Center, ERIC Document Number ED 034 859.

<sup>52</sup>Lorraine Pearl Missling, "A Comparison of the Traditional Plan to Selected Flexible Modular Plans in First Semester High School Typewriting with Straight-Copy Achievement and Production Achievement as Criteria," Dissertation Abstracts International, XXXI (June, 1971), p. 6487-A.

Education, involves over fifty high schools in five states. This research effort is being conducted in cooperation with State Departments of Education in Arizona, Florida, Michigan, New Jersey, and Washington.

#### SUMMARY

No research available at this time supports the existence of a state of mental fatigue comparable to the state of physical fatigue. The willingness or ability of learners to persevere at a learning task appears to be a function of motivation rather than fatigue. In the typical scholastic setting pupils seem to learn best when periods of learning practice are broken by periods of rest or a change in activity. There is no theoretical or scientific basis for scheduling secondary school classes in periods of forty to sixty minutes duration.

Research has generally shown that learning achievement is greater for pupils who spend the longer total amounts of time studying or receiving instruction in a subject. It has not been conclusively shown that either shortening or lengthening periods of instruction has any significant effect on pupil achievement so long as the total length of time spent in learning activity remains the same.

Pupils who have been taught subjects in multiple-period classes where the content of two courses was integrated or correlated have been found to achieve as well as, or better than, students taught the same subjects in conventional single-period, separate-subject classes. Parents, teachers, and pupils have generally been reported to like multiple-period, core curriculum plans of organization.

Findings of studies of the effects of flexible schedules on pupil achievement have generally agreed that pupils in flexibly scheduled schools learn as well as, or better than, pupils in traditionally scheduled schools. No studies reviewed in this chapter found the achievement of pupils in traditionally scheduled schools to be superior to achievement of pupils in flexibly scheduled schools.

Most studies of pupil and teacher attitudes toward flexibly scheduled programs report that, in general, both pupils and teachers have favorable attitudes toward this approach to scheduling and toward their schools.

Vocational educators have found extended class periods to be suitable for those courses because the extended periods allow closer simulation of on-the-job conditions.

## CHAPTER III

### METHOD OF RESEARCH

The design for this study was quasi-experimental<sup>1</sup> involving pretesting, experimental treatment, and posttesting of experimental groups, and pretesting and posttesting of control groups. The study also included follow-up testing in all groups. The study included two separate investigations, A and B, holding the teacher variable constant in each investigation. Each investigation was, then, a replication of the other with different teacher teams and different student subjects involved in each investigation.

### SELECTION OF COURSES

The courses selected for this study were high school courses in Biology I and in Plane and Solid Geometry. These courses were chosen after consulting with the teaching staff in the participating high school. They were selected for the study for the following reasons: (A) The staff believed the long-block-of-time class schedule would be most advantageous to instruction in a laboratory science taught largely through the medium of investigation and guided inquiry. (B) The staff believed the long-block-of-time class schedule would be most disadvantageous to instruction in mathematics. (C) The specific courses of biology and geometry were selected because large numbers of students normally enroll for both of these classes simultaneously, thus making available the largest possible population from which to draw subjects for the experimental groups.

### POPULATION

#### The Experimental Groups

Subjects for the experimental groups were chosen from a pool of one hundred and four students at Cape Girardeau, Missouri, Central High School who were pre-enrolled for both biology and

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<sup>1</sup>Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research (Chicago: Rand McNally and Company, 1969), pp. 47-50.

geometry. These students were randomly divided into two subgroups of fifty-two students each, subgroups A and B. Each subgroup was assigned to a separate investigation, either A or B.

The chronological age of each subject was established to the nearest month as of the first day of the school term, September 1, 1970. This was done by taking each subject's birthdate from his official school record.

An estimate of each subject's mental age was established to the nearest month as of the first day of the school term. This was done by first taking the two most recent intelligence quotients (IQ scores) recorded on the subject's official school record and averaging them.

$$(1) \quad \frac{IQ_1 + IQ_2}{2} = \text{Average IQ}$$

The average IQ was then divided by 100 and the quotient obtained for each subject was multiplied by the subject's chronological age to the nearest month as of the first day of the school term to establish the estimate of mental age.

$$(2) \quad \frac{\text{Average IQ}}{100} \times CA = MA$$

From the fifty-two available subjects assigned to Investigation A, twenty-four pairs of subjects were then selected for assignment to one of two class groups, A<sub>1</sub> or A<sub>2</sub>. This initial matching was done by pairing subjects as closely as possible on the variables of grade in school, chronological age, and mental age. In Investigation A it was possible to match twenty-four pairs of subjects exactly on grade in school who also differed five months or less on chronological age. One matched pair differed more than five months in mental age.

From the fifty-two available subjects assigned to Investigation B, twenty-four pairs of subjects were then selected for assignment to one of two class groups, B<sub>1</sub> or B<sub>2</sub>. The initial matching paired subjects as closely as possible on the variables described for Investigation A, above. Subjects assigned to Investigation B were found to be a more heterogeneous group than those assigned to Investigation A. However, in the initial matching of groups it was still possible to match twenty-two of the twenty-four pairs exactly on grade in school; the other two pairs differing by one grade. It was possible to match twenty of the twenty-four pairs within five months or less on chronological age; the other four pairs differing from six to sixteen months. It was possible to match twenty-two of the twenty-four pairs within five months or less on mental age; the other two pairs differing 5.2 months and 26 months, respectively, in mental age.

### The Control Groups

Subjects for the biology control groups,  $A_9$  and  $B_9$ , were arbitrarily selected from a pool of one hundred and eighty students who were pre-enrolled for biology at Cape Girardeau Central High School. The chronological and mental ages were established for each subject in this pool using the same procedures which were followed in establishing these ages for subjects in the experimental groups.

Subjects assigned to control class group  $A_9$  were selected one at a time to match as closely as possible each matched pair of subjects in experimental class groups  $A_1$  and  $A_2$  on the variables of grade in school, chronological age, and mental age. It was possible to match all but one subject in  $A_9$  exactly with a matched pair in  $A_1$  and  $A_2$  on grade in school. One subject in  $A_9$  differed greater than five months in chronological age from his matched counterpart in  $A_2$ . No subject in  $A_9$  differed more than five months in mental age from the matched pair in  $A_1$  and  $A_2$ .

Subjects assigned to biology control class group  $B_9$  were selected one at a time to match as closely as possible each pair of matched subjects in experimental class groups  $B_1$  and  $B_2$  on the variables previously specified for Investigation A. It was found that due to the heterogeneity previously described among subjects assigned to Investigation B, and because of the reduction in the number of available subjects resulting from the loss of subjects assigned to  $A_9$ , it was not possible to match control subjects in Investigation B as precisely as had been possible in Investigation A.

Between class groups  $B_9$  and  $B_1$  it was possible to match twenty-one pairs of subjects on grade in school; the other three pairs differing by one year. It was possible to match nineteen pairs of subjects within five months on chronological age; the other five pairs differing from six to sixteen months. It was possible to match twenty-one pairs of subjects within five months on mental age; the other three pairs differing from 11 to 31.9 months.

Between class groups  $B_9$  and  $B_2$  it was possible to match eighteen pairs of subjects on grade in school; the other six pairs differing by one year. It was possible to match seventeen pairs of subjects within five months on chronological age; the other seven pairs differing from eight to eighteen months. It was possible to match twenty-one pairs of subjects within five months on mental age; the other three pairs differing from 5.3 to 22.1 months.

Subjects for geometry control groups  $A_{10}$  and  $B_{10}$  were arbitrarily selected from a pool of one hundred and thirty students who were pre-enrolled for geometry at Cape Girardeau Central High



School. Chronological and mental ages were established for each student in this pool using the same procedures described for the experimental and control groups, above.

Subjects assigned to control class group A<sub>10</sub> were selected one at a time to match as closely as possible each matched pair of subjects in experimental class groups A<sub>1</sub> and A<sub>2</sub> on the variables of grade in school, chronological age, and mental age. It was possible to match all subjects in A<sub>10</sub> exactly with a matched pair in A<sub>1</sub> and A<sub>2</sub> on grade in school. Two subjects in A<sub>10</sub> differed greater than five months in chronological age from one of their matched counterparts in either A<sub>1</sub> or A<sub>2</sub>. No subject in A<sub>10</sub> differed more than five months in mental age from his counterparts in A<sub>1</sub> and A<sub>2</sub>.

Subjects assigned to geometry control class group B<sub>10</sub> were selected one at a time to match as closely as possible each pair of matched subjects in experimental class groups B<sub>1</sub> and B<sub>2</sub> on the variables previously specified for all other groups. It was found that the greater heterogeneity of subjects in Investigation B, and the reduction in the number of available subjects resulting from the loss of subjects assigned to A<sub>10</sub>, made it impossible to match control subjects in B<sub>10</sub> as precisely as had been possible in A<sub>10</sub>.

Between class groups B<sub>10</sub> and B<sub>1</sub> it was possible to match eighteen pairs of subjects on grade in school; the other six pairs differing by one year. It was possible to match fifteen pairs of subjects within five months on chronological age; the other nine pairs differing from seven to twenty months. It was possible to match twenty-one pairs of subjects within five months on mental age; the other three pairs differing from 10.4 to 44.2 months.

Between class groups B<sub>10</sub> and B<sub>2</sub> it was possible to match sixteen pairs of subjects on grade in school; the other eight pairs differing by one year. It was possible to match fifteen pairs of subjects within five months on chronological age; the other nine pairs differing from six to twenty-two months. It was possible to match twenty-one pairs of subjects within five months on mental age; the other three pairs differing from 6.1 to 10 months.

#### INSTRUCTORS

Four teachers were chosen from the instructional staff at Cape Girardeau Central High School to participate in the study. Two of the teachers were biology teachers and two were mathematics teachers. The teachers were selected on the bases of their subject specializations, their expertise as teachers as evaluated by their principal and the director of secondary education, their willingness to try new approaches to instruction, and their interest in the proposed study.

The participating teachers were divided into two teams, A and B, each team having one biology and one mathematics teacher. One team (Team A) was assigned to teach both the experimental and control class groups in Investigation A. The other team (Team B) was assigned to teach both the experimental and control class groups in Investigation B.

#### DESIGN

Experimental class groups  $A_1$  and  $A_2$  were scheduled with the teachers on Team A for 110-minute classes in biology one semester and 110-minute classes in geometry the other semester. Each semester included ninety class periods scheduled to meet daily. Students in groups  $A_1$  and  $A_2$  thus completed one hundred and sixty-five clock hours of inclass instruction for one Carnegie Unit of credit in each course during the semester in which it was taken.

Simultaneously, teachers in Team A taught a control group class in their field of specialization. Control group classes were scheduled fifty-five minutes each day for one hundred and eighty days to complete one hundred and sixty-five clock hours of instruction for one Carnegie Unit of credit.

Investigation B was a replication of the design of Investigation A involving a different team of teachers (Team B) and different class groups (Groups  $B_1$ ,  $B_2$ ,  $B_9$ , and  $B_{10}$ ). Figure 1 presents a schematic model of the research design.

#### CONTROL OF METHODS OF INSTRUCTION

Teachers in each investigation were given freedom to determine their daily methods of instruction so long as they kept them as constant as possible in both their experimental and control groups. Teachers did not depart from the methods of instruction they had been accustomed to using even though the long-block-of-time experimental classes did present them with an opportunity to do so. A daily log record of lesson plans was kept by each teacher to insure that methods of presentation were kept constant. Copies of log record forms are exhibited in Appendix A. Care was taken to insure that the different lengths of class periods would be the only manipulated variable which would influence the dependent variable, achievement gain.



FIGURE 1  
SCHEMATIC MODEL OF THE RESEARCH DESIGN

Investigation A

|         |  |  |
|---------|--|--|
|         | First Semester                         | Second Semester                        |
| BIOLOGY | Biology Group A <sub>1</sub>           | Biology Group A <sub>2</sub>           |
| TEACHER | 110-minute class period<br>for 90 days | 110-minute class period<br>for 90 days |

A

|                                     |
|-------------------------------------|
| Biology Group A <sub>9</sub>        |
| 55-minute class period for 180 days |

|          |  |  |
|----------|--|--|
|          | First Semester                         | Second Semester                        |
| GEOMETRY | Geometry Group A <sub>2</sub>          | Geometry Group A <sub>1</sub>          |
| TEACHER  | 110-minute class period<br>for 90 days | 110-minute class period<br>for 90 days |

A

|                                     |
|-------------------------------------|
| Geometry Group A <sub>10</sub>      |
| 55-minute class period for 180 days |

Investigation B

|         |  |  |
|---------|--|--|
|         | First Semester                         | Second Semester                        |
| BIOLOGY | Biology Group B <sub>1</sub>           | Biology Group B <sub>2</sub>           |
| TEACHER | 110-minute class period<br>for 90 days | 110-minute class period<br>for 90 days |

B

|                                     |
|-------------------------------------|
| Biology Group B <sub>9</sub>        |
| 55-minute class period for 180 days |

|          |  |  |
|----------|--|--|
|          | First Semester                         | Second Semester                        |
| GEOMETRY | Geometry Group B <sub>2</sub>          | Geometry Group B <sub>1</sub>          |
| TEACHER  | 110-minute class period<br>for 90 days | 110-minute class period<br>for 90 days |

B

|                                     |
|-------------------------------------|
| Geometry Group B <sub>10</sub>      |
| 55-minute class period for 180 days |

## COLLECTION OF DATA

### Biology Achievement

Data to test hypothesis 1 were collected as follows.

The experimental and control groups for biology in both Investigations A and B were pretested and posttested using the BSCS Green Version High School Biology Comprehensive Final Examination: Form L.<sup>2</sup> Since comparable alternate forms of this test are not available, it was necessary to use the same form for both the pretest and the posttest.

Pretests were given in all experimental groups ( $A_1$ ,  $B_1$ ,  $A_2$ , and  $B_2$ ) on the third day they attended classes. At that time each class had completed two hundred and twenty minutes of orientation to the class but had not been initiated to formal instruction in the course. The raw score for each subject was assumed to be the entry achievement score for that subject in biology.

Posttests were given in all experimental biology groups ( $A_1$ ,  $B_1$ ,  $A_2$ , and  $B_2$ ) on the eighty-ninth day they attended classes. At that time each class had completed one hundred and sixty-three clock hours of inclass orientation and instruction in the course. The raw score for each subject was assumed to be the final achievement score for that subject.

Control groups in biology ( $A_0$  and  $B_0$ ) were pretested on the fifth day they attended classes. At that time they had completed two hundred and twenty minutes of orientation to the class but had not been initiated to formal instruction in the subject. The raw score for each subject was assumed to be the entry achievement score for that subject in biology.

Posttests were given in both control biology groups ( $A_0$  and  $B_0$ ) on the one hundred and seventy-eighth day they attended classes. At that time each class had completed one hundred and sixty-three clock hours of inclass orientation and instruction in the course. The raw score for each subject was assumed to be the final achievement score for that subject.

### Geometry Achievement

Data to test hypothesis 2 were collected as follows.

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<sup>2</sup>Miller and Leth, loc. cit.

The experimental and control groups for geometry in both Investigations A and B were pretested and posttested using the Howell Geometry Test.<sup>3</sup> Form A was used for pretesting and form B was used for posttesting.

Pretests were given in all experimental groups ( $A_1$ ,  $B_1$ ,  $A_2$ , and  $B_2$ ) on the third day they attended classes. At that time each class had completed two hundred and twenty minutes of orientation to the class but had not been initiated to formal instruction in the course. The raw score for each subject was assumed to be the entry achievement score for that subject in geometry.

Posttests were given in all experimental geometry groups ( $A_1$ ,  $B_1$ ,  $A_2$ , and  $B_2$ ) on the eighty-ninth day they attended classes. At that time each class had completed one hundred and sixty-three clock hours of inclass orientation and instruction in the course. The raw score for each subject was assumed to be the final achievement score for that subject in geometry.

Control groups in geometry ( $A_{10}$  and  $B_{10}$ ) were pretested on the fifth day they attended classes. At that time they had completed two hundred and twenty minutes of orientation to the class but had not been initiated to formal instruction in the subject. The raw score for each subject was assumed to be the entry achievement score for that subject in geometry.

Posttests were given in both control geometry groups ( $A_{10}$  and  $B_{10}$ ) on the one hundred and seventy-eighth day they attended classes. At that time each class had completed one hundred and sixty-three clock hours of inclass orientation and instruction in the course. The raw score for each subject was assumed to be the final achievement score for that subject in geometry.

#### Biology Retention

Data to test hypothesis 3 were collected as follows.

Eight-month follow-up tests were given to all surviving subjects from biology classes two hundred and forty-one days following the final day the class had met. The BSCS Green Version High School Biology Comprehensive Final Examination, Form L was used. The raw score for each subject was assumed to be the retention score for that subject in biology.

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<sup>3</sup>Howell, loc. cit.

### Geometry Retention

Data to test hypothesis 4 were collected as follows.

Eight-month follow-up tests were given to all surviving subjects from geometry classes two hundred and forty-one days following the final day the class had met. The Howell Geometry Test, Form A, was used. The raw score for each subject was assumed to be the retention score for that subject in geometry.

### Scheduling Preferences

Data to test hypotheses 5-A, 5-B, 5-C, and 5-D were collected as follows.

A checklist opinionnaire, the Student Preference Opinionnaire on Allocation of Class Time, was developed by the investigator. This opinionnaire is shown in Appendix B. The opinionnaire was designed to (1) sample student opinion for the ninety-day, 110-minute class time allocation; for the one hundred and eighty day, 55-minute class time allocation; or no preference, and (2) to identify students' reasons for their preferences.

The opinionnaire was administered only to students in experimental class groups on the last day they attended classes in each course. The opinions of control group subjects were not sampled since they had not experienced instruction in the long-block-of-time class situation.

### Adjustments in Instructional Method

Question 4 considered the adjustments in instructional method teachers found desirable or necessary in order to adapt instructional methods to the long-block-of-time class. No hypotheses were stated for this question.

Project teachers maintained a daily log of class activities. The log included a daily lesson plan, a daily evaluation of instruction, and a unit summary evaluation of instruction for both experimental and control groups. Following the completion of each class the teachers prepared a written summary of their observations based on data recorded in their log records.

## EVALUATION INSTRUMENTS

### Test of Biology Achievement

The BSCS High School Biology: Green Version, Second Edition, program was used as the basic approach to instruction in all participating biology classes. After making an item content analysis of three standardized biology achievement tests, biology teachers at the participating high school selected the BSCS Green Version High School Biology Comprehensive Final Examination: Form L as the instrument having the highest content validity for purposes of evaluating instruction in the BSCS Green Version program. This test was chosen to evaluate pretest, posttest, and follow-up achievement in research classes.

The test is published by Rand McNally and Company, publisher of all BSCS Green Version materials. It was developed by a committee of teachers, biologists, psychologists, and psychometrists simultaneously with the development of the instructional program. The test is designed to measure both concepts and factual information which each student should acquire as a result of having completed the BSCS Green Version course of study. The instrument is reported by the publisher to have been tested on several hundreds of students in BSCS Green Version classes.

The test was copyrighted in 1968 and is not included in the 1965 Buros Mental Measurement Yearbook. To date, no coefficient of reliability on a norm population has been determined by the test publisher.

### Test of Geometry Achievement

The Howell Geometry Test, Forms A and B, was used to obtain pretest, posttest, and follow-up measurements in all research classes in geometry.

During the school year preceding this study, 1969-70, a committee of three geometry teachers and the chairman of the mathematics department at the participating high school made an item content analysis of three standardized tests of geometry achievement. This committee chose the Howell Geometry Test over the other two instruments as the test having the highest content validity for purposes of evaluating pupil achievement in the geometry course being taught at the school. At the end of that school year, the test was given to all geometry students who were completing the course in geometry. Each teacher then correlated the rank of students on the test in each class section with the rank of students on each instructor's teacher-made final examination. The correlations varied, but were consistently high.

The analysis of item content and the trial administration of the test indicated it to be the most satisfactory standardized test of geometry achievement available for purposes of this study.

The Howell Geometry Test is designed to measure geometry achievement in three major cognitive categories--knowledge, understanding, and application. The test items are written in the vocabulary of the new mathematics curriculums, and attempt to reflect changes in emphasis resulting from the "modern math" revolution. It has been validated and norms have been established on a population of 7,163 high school geometry students in thirty-three public high schools in twenty-four states. The split-half coefficient of reliability for the total norm group, corrected by the Spearman-Brown Prophecy Formula is .82 for both forms.

The test was copyrighted in 1969 by Harcourt, Brace and World, Inc. and is not included in the 1965 Buros Mental Measurement Yearbook.

#### Student Preference Opinionnaire

The Student Preference Opinionnaire on Allocation of Class Time was developed by the investigator.

In Part I of this opinionnaire each respondent was asked to express his preference for the ninety-day, 110-minute class period; the one hundred and eighty-day, 55-minute class period; or no preference for one class time allocation over the other.

In Part II those students who preferred the ninety-day, 110-minute class period and those with no preference were asked to respond to a checklist of reasons for liking the long-block-of-time class period. In addition, respondents were invited to add other unrestricted written comments to express their reasons for preferring this kind of schedule.

In Part III those students who preferred the one hundred and eighty-day, 55-minute class period and those with no preference were asked to respond to a checklist of reasons for preferring the traditional class period arrangement. Respondents were invited to add other written comments to express their reasons for preferring this kind of schedule.

The Student Preference Opinionnaire on Allocation of Class Time is shown in Appendix B.

## ANALYSIS OF DATA

### Biology Achievement

Biology achievement data were tested for significance of difference between adjusted group means through analysis of covariance using pretest scores as the concomitant variable. This approach to data treatment was chosen for these reasons:

1. Maximum precision in interpretation was desired.<sup>4</sup>
2. Difficulties encountered in precisely matching sets of subjects in Investigation B raised some question about the equivalence of groups. Yet, the lack of true randomization in the assignment of subjects made each class group, in fact, an intact class group. This questionable experimental control made statistical control appealing to lend credibility to the findings.<sup>5</sup>
3. The small numbers of subjects (24) assigned originally to the class groups were further decreased by subject mortality during the year. Other approaches to precise data analysis would have necessitated eliminating subjects from the already small population.
4. The assumptions prerequisite to the use of analysis of covariance were present in the data.<sup>6</sup> (It should be noted that random assignment of subjects to treatment groups is an assumption which may be violated when using analysis of covariance.)<sup>7</sup>

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<sup>4</sup>Leonard S. Feldt, "A Comparison of the Precision of Three Experimental Designs Employing a Concomitant Variable," Psychometrika, XXIII (December, 1958), pp. 335-353.

<sup>5</sup>Jerome L. Myers, Fundamentals of Experimental Design (Boston: Allyn and Bacon, Inc., 1966), pp. 322-23.

<sup>6</sup>Allen L. Edwards, Experimental Design in Psychological Research (New York: Holt, Rinehart and Winston, Inc., 1968), p. 332.

<sup>7</sup>Myers, op. cit., p. 323.

Raw score means for each group were used as indicants of entry achievement and final achievement for biology classes.

#### Geometry Achievement

Statistical adjustment of posttest group means to account for the influence of pretest achievement would have been the preferred approach to data analysis for a quasi-experimental design such as this. However, it was found that the correlations between pretest and posttest geometry scores were not sufficiently high to make analysis of covariance a worthwhile statistical technique to reduce error variance.

Pretreatment equivalence of geometry groups in each investigation was verified by testing their variances for homogeneity and their means for significance of difference. It was found that prior to introduction of the experimental treatment the three class groups in each geometry investigation were equivalent groups within the limits of normally expected random variation. Geometry posttest achievement data were then tested for significance of difference between group means through analysis of variance.

#### Biology Retention

In order to be consistent with the method used to test hypothesis 1, analysis of covariance was used to test the statistical significance of differences between follow-up test group means for groups in each biology investigation. Posttest raw scores were used as the concomitant variable for purposes of adjusting follow-up test scores.

#### Geometry Retention

In order to be consistent with the method used to test hypothesis 2, analysis of variance was used to test the statistical significance of differences between follow-up test group means for groups in each geometry investigation. Follow-up test variances were tested for homogeneity with the  $F_{\max}$  test.

#### Scheduling Preferences

Part I of the Student Preference Opinionnaire on Allocation of Class Time gave pupils an opportunity to express a preference for the long-block-of-time class period, the traditional class period, or no preference for one allocation of class time over the other. Responses to Part I were tallied, totaled, and expressed as a percentage of the total respondents, (A) by class groups, (B) by



each teacher's combined class groups, (C) by course, (D) by semester the courses were taken, and (E) by totals for all subjects responding.

Hypotheses 5-A, 5-B, 5-C, and 5-D were tested for significance of difference at the .01 level of confidence using the chi square test of significance.

Items in Part II of the opinionnaire stated in checklist form six reasons a student might have for preferring the long-block-of-time class period. Students who had expressed a preference for the experimental class period and those who had expressed no preference, in Part I, were instructed to respond to Part II by checking the listed reasons they had for liking the long-block-of-time class period. The items checked were tallied and the totals were expressed numerically and as a percentage of the total number of respondents to Part II.

Items in Part III of the opinionnaire stated in checklist form four reasons a student might have for preferring the traditional class period. Students who had expressed a preference for the traditional class period and those who had expressed no preference, in Part I, were instructed to respond to Part III by checking the listed reasons they had for liking the traditional class period. The items checked were tallied and the totals were expressed numerically and as a percentage of the total number of respondents to Part III.

At the end of Parts II and III students were instructed to add in writing any reasons they had for preferring one type of class time allocation over the other which had not been included in the checklist for that part of the opinionnaire.

When unrestricted written responses appeared with enough similarity to defend clustering them into categories of similar responses, this was done. When clustering of written responses resulted in a number of responses in one category equal to ten percent or more of the total number of respondents, that category was reported along with the checklist responses.

#### Adjustments in Instructional Method

Project teachers were instructed to report, in summary form, their observations of the relative strengths and weaknesses of the long-block-of-time class period when compared to the traditional class period. Specifically, they were required to report their observations concerning the effects of the experimental class period on six aspects of instructional methodology and classroom management.

The teachers were also asked to report, in summary form, any other observations they wished to make about the comparative strengths and weaknesses of the long-block-of-time class period.

The content of each teacher's reported observations was analyzed and similar observations were collated and reported in narrative form.

### SUMMARY

Experimental and control classes in Biology I and Plane and Solid Geometry were used for this study. Achievement and retention data were gathered by using the BSCS Green Version High School Biology Comprehensive Final Examination, Form L, and the Howell Geometry Test, Forms A and B, as indicants of achievement in the two kinds of classes, respectively. Classes were pretested, posttested and follow-up tested. Groups were equated both through research design and statistically.

An opinionnaire constructed by the researcher was used to gather data about scheduling preferences of pupils.

Teachers kept daily log records of observations concerning adjustments in instructional methods and classroom management which were necessary or desirable in order to adapt instruction to the experimental class period.

## CHAPTER IV

### REPORT OF FINDINGS RELATIVE TO PUPIL ACHIEVEMENT

One of the major questions which this study sought to answer dealt with the effects of the long-block-of-time class period on the achievement of pupils in biology and geometry. Research hypotheses one and two were concerned with this question. These hypotheses were:

(1) That high school pupils in biology meeting in daily classes of 110 minutes for ninety days would not differ significantly in measurable cognitive learning achievement from similar pupils in biology meeting in daily classes of 55 minutes for one hundred and eighty days.

(2) That high school pupils in geometry meeting in daily classes of 110 minutes for ninety days would not differ significantly in measurable cognitive learning achievement from similar pupils in geometry meeting in daily classes of 55 minutes for one hundred and eighty days.

### PRE-TREATMENT CHARACTERISTICS OF SUBJECTS

Subjects for experimental groups were selected from a population of one hundred and four pupils at Cape Girardeau, Missouri, Central High School who were pre-enrolled for both biology and geometry. These subjects were divided for two investigations, A and B, making a pool of fifty-two subjects available for each. Within each investigation these subjects were then divided into two experimental class groups,  $A_1$  and  $A_2$ , or  $B_1$  and  $B_2$ , each class group having twenty-four subjects. This division was made by matching pairs of subjects on the basis of grade in school, chronological age, and mental age. Selection and assignment procedures are described in Chapter III.

Subjects for control groups in biology,  $A_0$  and  $B_0$ , were selected from a pool of one hundred and eighty pupils at Cape Girardeau Central High School who were pre-enrolled for biology but were not pre-enrolled simultaneously for geometry. These subjects were assigned individually to control group  $A_0$  or  $B_0$  by matching each with a matched pair of subjects in the corresponding experimental groups on the variables of grade in school, chronological age, and mental age, as described in Chapter III.

Subjects for control groups in geometry, A<sub>10</sub> and B<sub>10</sub>, were selected from a pool of one hundred and thirty pupils in the cooperating school who were pre-enrolled for geometry but were not pre-enrolled simultaneously for biology. These subjects were assigned individually to control class groups A<sub>10</sub> or B<sub>10</sub> by matching each with a matched pair of subjects in the corresponding experimental groups on the variables of grade in school, chronological age, and mental age, as described in Chapter III.

In addition to the difficulties encountered in matching experimental and control group subjects in the original groups, a loss of subjects from the study during the year further influenced the precision of matching. Still, at the time of posttesting, the experimental and control groups in each investigation remained relatively homogeneous on the variables selected for purposes of matching.

After the pre-treatment characteristics for all subjects who failed to complete the study were eliminated from the data, the greatest difference in mean grade in school found between an experimental and a control group in the same investigation was .3 years. This difference was found to exist between Geometry Groups B<sub>2</sub> and B<sub>10</sub>. These two groups also differed most in mean chronological age, 4.6 months. The greatest difference between matched experimental and control groups in mean mental age was 2.0 months. This difference was found between Geometry Groups A<sub>1</sub> and A<sub>10</sub>.

The pre-treatment characteristics of each subject who remained at the time of posttesting are presented by matched groups in Appendix C. A summary of these pre-treatment characteristics is shown by groups in Table I.

#### ANALYSIS OF DATA: BIOLOGY INVESTIGATIONS A AND B

##### Source of Data for Biology Achievement

The critical variable to test hypothesis one was posttest achievement in biology as measured by the BSCS Green Version High School Biology Comprehensive Final Examination, Form L. This test was described in Chapter III.

##### Method of Data Analysis for Biology Achievement

In addition to attempting to control pre-treatment differences between groups experimentally by matching subjects on three variables, reduction of experimental error was also sought by

TABLE I

SUMMARY OF PRE-TREATMENT CHARACTERISTICS OF SUBJECTS,  
GRADE IN SCHOOL, CHRONOLOGICAL AGE, AND MENTAL AGE  
INVESTIGATIONS A AND B

Biology Investigation A:

| <u>Characteristic</u>  | <u>Group A<sub>1</sub></u> | <u>Group A<sub>9</sub></u> | <u>Group A<sub>2</sub></u> |
|------------------------|----------------------------|----------------------------|----------------------------|
| Mean Grade in School   | 9.6                        | 9.6                        | 9.7                        |
| Mean Chronological Age | 179.7                      | 179.8                      | 180.4                      |
| Mean Mental Age        | 214.1                      | 213.6                      | 212.0                      |
| Posttest Group Size    | 22                         | 24                         | 19                         |

Biology Investigation B:

| <u>Characteristic</u>  | <u>Group B<sub>1</sub></u> | <u>Group B<sub>9</sub></u> | <u>Group B<sub>2</sub></u> |
|------------------------|----------------------------|----------------------------|----------------------------|
| Mean Grade in School   | 9.3                        | 9.2                        | 9.3                        |
| Mean Chronological Age | 177.3                      | 176.0                      | 176.9                      |
| Mean Mental Age        | 215.3                      | 214.2                      | 215.5                      |
| Posttest Group Size    | 23                         | 22                         | 23                         |

Geometry Investigation A:

| <u>Characteristic</u>  | <u>Group A<sub>1</sub></u> | <u>Group A<sub>10</sub></u> | <u>Group A<sub>2</sub></u> |
|------------------------|----------------------------|-----------------------------|----------------------------|
| Mean Grade in School   | 9.6                        | 9.7                         | 9.7                        |
| Mean Chronological Age | 179.6                      | 180.6                       | 180.0                      |
| Mean Mental Age        | 215.3                      | 213.3                       | 212.9                      |
| Posttest Group Size    | 21                         | 24                          | 21                         |

Geometry Investigation B:

| <u>Characteristic</u>  | <u>Group B<sub>1</sub></u> | <u>Group B<sub>10</sub></u> | <u>Group B<sub>2</sub></u> |
|------------------------|----------------------------|-----------------------------|----------------------------|
| Mean Grade in School   | 9.4                        | 9.6                         | 9.3                        |
| Mean Chronological Age | 177.3                      | 181.5                       | 176.9                      |
| Mean Mental Age        | 216.0                      | 216.0                       | 215.5                      |
| Posttest Group Size    | 22                         | 21                          | 23                         |

statistical adjustment of the dependent measures. One important concomitant variable, pre-treatment achievement, could not be experimentally controlled through pairing of subjects. For this reason and other reasons described in Chapter III, analysis of covariance using pretest measures of achievement as the concomitant variable was selected to test the data collected for differences between groups.

Analysis of covariance is a statistical method of reducing the estimate of experimental error by taking into account the regression of measures of the dependent variable on measures of a supplementary or concomitant variable. Feldt<sup>1</sup>, Myers<sup>2</sup>, Edwards<sup>3</sup>, and others have endorsed analysis of covariance as an appropriate technique for reducing experimental error, especially when working with already established groups such as classes. Campbell and Stanley recommend this approach to treatment of data in quasi-experimental pretest/posttest, experimental and control group research designs any time pre-treatment equivalence of intact groups is open to question.<sup>4</sup>

Pretest and posttest data collected from both Investigations A and B met the essential basic assumptions for using analysis of covariance.<sup>5</sup> The Pearson product-moment correlations for all pretest with posttest measures, shown in Table II, were sufficiently high in both biology investigations to make covariance analysis a worthwhile approach to reducing experimental error.<sup>6</sup>

#### Report of Findings for Biology Investigation A

Complete pretest and posttest achievement data for subjects in Biology Investigation A are presented, by group, in Appendix D.

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<sup>1</sup>Leonard S. Feldt, "A Comparison of the Precision of Three Experimental Designs Employing a Concomitant Variable," Psychometrika, XXIII (December, 1958), pp. 335-353.

<sup>2</sup>Jerome L. Myers, Fundamentals of Experimental Design (Boston: Allyn and Bacon, Inc., 1966), pp. 322-23.

<sup>3</sup>Allen L. Edwards, Experimental Design in Psychological Research (New York: Holt, Rinehart and Winston, Inc., 1968), p. 346.

<sup>4</sup>Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research, (Chicago: Rand McNally and Company, 1969), p. 49.

<sup>5</sup>Myers, op. cit., p. 302.

<sup>6</sup>Ibid., p. 324.

TABLE II

SUMMARY OF BSCS HIGH SCHOOL BIOLOGY: GREEN VERSION FINAL  
ACHIEVEMENT TEST PRETEST/POSTTEST CORRELATIONS  
BIOLOGY INVESTIGATIONS A AND B

| Investigation A: |                                     | Investigation B: |                                     |
|------------------|-------------------------------------|------------------|-------------------------------------|
| Group            | Pretest/Posttest<br>Correlation (r) | Group            | Pretest/Posttest<br>Correlation (r) |
| A <sub>1</sub>   | .737                                | B <sub>1</sub>   | .726                                |
| A <sub>9</sub>   | .643                                | B <sub>9</sub>   | .737                                |
| A <sub>2</sub>   | .588                                | B <sub>2</sub>   | .675                                |

Following adjustment of posttest group means to account for the effects of pretest achievement, the adjusted posttest means for Biology Groups A<sub>1</sub>, A<sub>9</sub>, and A<sub>2</sub> were 21.55, 23.60, and 25.60, respectively. Pretest and posttest data and the adjusted group means are summarized in Table III.

The regression of dependent measures on concomitant measures for the three groups in Investigation A was found to be within the limits of random variation, thus permitting group regression lines to be pooled as required in the covariance analysis technique.

TABLE III

SUMMARY OF GROUP PRETEST AND POSTTEST ACHIEVEMENT DATA  
BIOLOGY INVESTIGATION A

| Characteristic              | Group A <sub>1</sub> | Group A <sub>9</sub> | Group A <sub>2</sub> |
|-----------------------------|----------------------|----------------------|----------------------|
| Pretest Mean                | 17.55                | 16.29                | 16.53                |
| Pretest Standard Deviation  | 5.19                 | 4.40                 | 4.02                 |
| Posttest Mean               | 22.23                | 23.17                | 25.37                |
| Posttest Standard Deviation | 6.08                 | 6.11                 | 6.35                 |
| Adjusted Mean               | 21.55                | 23.60                | 25.60                |

In Investigation A, the F test applied to the adjusted between groups mean squares produced an F ratio of 3.80 as shown in Table IV. An F ratio in excess of 3.15 is necessary to reject the hypothesis of no difference at the .05 level of significance with two and sixty-one degrees of freedom. Therefore, a difference did appear to exist between the adjusted group means of the three classes in Investigation A.

TABLE IV

SOURCE TABLE: BIOLOGY INVESTIGATION A

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 165.98          | 2.00               | 82.99       | 3.80*   |
| Within Groups  | 1,333.82        | 61.00              | 21.87       |         |
| Total          | 1,499.80        | 63.00              |             |         |

\*A critical value of 3.15 is required for significance at the .05 level of confidence with 2 and 61 degrees of freedom.

The Scheffe Test for Multiple Comparisons was used to identify which adjusted group means differed from each other, interpreted at the .10 level of confidence as recommended in Edwards.<sup>7</sup> This t test for significance identified only one significant difference between the adjusted group means of groups in Biology Investigation A. The t ratio of 1.96 found between the means of experimental groups A<sub>1</sub> and A<sub>2</sub> was significant at the .10 level of confidence. However, neither of the adjusted group means of the experimental groups, A<sub>1</sub> or A<sub>2</sub>, differed significantly from the adjusted mean of the control group, A<sub>9</sub>, at the established level of confidence. Apparently the difference in achievement was unrelated to the independent variable, the variation in class period length. The hypothesis of no difference in achievement between experimental and control groups could not be rejected, even though a significant F ratio was found.

<sup>7</sup>Edwards, op. cit., pp. 150-53.



### Report of Findings for Biology Investigation B

Complete pretest and posttest achievement data for subjects in Biology Investigation B are presented, by group, in Appendix D. Following adjustment of posttest group means to account for the effects of pretest achievement, the adjusted posttest means for Biology Groups B<sub>1</sub>, B<sub>9</sub>, and B<sub>2</sub> were 24.35, 25.61, and 23.46 respectively. A summary of pretest and posttest data and the adjusted means for groups in Biology Investigation B is shown in Table V.

TABLE V  
SUMMARY OF GROUP PRETEST AND POSTTEST ACHIEVEMENT DATA  
BIOLOGY INVESTIGATION B

| Characteristic             | Group B <sub>1</sub> | Group B <sub>9</sub> | Group B <sub>2</sub> |
|----------------------------|----------------------|----------------------|----------------------|
| Pretest Mean               | 19.13                | 16.36                | 19.39                |
| Pretest Standard Deviation | 4.58                 | 4.33                 | 5.07                 |
| Posttest Mean              | 25.09                | 23.82                | 24.43                |
| Posttest Stand Deviation   | 6.16                 | 5.62                 | 6.25                 |
| Adjusted Mean              | 24.35                | 25.61                | 23.46                |

In Biology Investigation B the regression of dependent measures on concomitant measures in all groups was found not to differ significantly in slope, thus permitting the analysis of covariance to proceed.

In Biology Investigation B a comparison of adjusted between groups mean squares produced an F ratio of 1.33 as shown in Table VI. This F ratio was non-significant at the .05 level of confidence, the critical ratio being 3.14 with two and sixty-four degrees of freedom.

Since no significant difference was found between the adjusted posttest means of the experimental and control groups in either Biology Investigation A or Biology Investigation B, the research hypothesis of no significant difference in cognitive learning achievement between groups of biology students in traditional classes and those in long-block-of-time classes could not be rejected on the basis of the data.

TABLE VI  
SOURCE TABLE: BIOLOGY INVESTIGATION B

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 48.77           | 2.00               | 24.39       | 1.33*   |
| Within Groups  | 1,171.06        | 64.00              | 18.30       |         |
| Total          | 1,219.83        | 66.00              |             |         |

\*A critical value of 3.14 is required for significance at the .05 level of confidence with 2 and 64 degrees of freedom.

#### ANALYSIS OF DATA: GEOMETRY INVESTIGATIONS A AND B

##### Source of Data for Geometry Achievement

The critical variable to test hypothesis two was achievement in geometry as indicated by posttest scores on the Howell Geometry Test, Form B. This test was described in Chapter III.

##### Method of Data Analysis for Geometry Achievement

Analysis of covariance using pretest measures as the concomitant variable was used as a method of statistical treatment to increase the precision of interpretation concerning differences between posttest mean scores for biology groups. As was pointed out in the preceding section, for analysis of covariance to be useful as an approach to reducing error variance, a substantial correlation must exist between the critical variable and the concomitant variable. Myers has suggested that this relationship should be at least .40 in order to bring about a significant reduction in the estimate of experimental error.<sup>8</sup> It was found that the Pearson product-moment coefficients of correlation between pretest and posttest raw scores for geometry varied from (-).066 to .541. Only

<sup>8</sup>Myers, loc. cit.

Geometry Group B<sub>1</sub> had a pretest/posttest coefficient of correlation higher than the .40 suggested by Myers as desirable to bring about a significant reduction in the error estimate through covariance analysis. Correlations of pretest with posttest raw scores for geometry groups are shown in Table VII.

TABLE VII  
SUMMARY OF HOWELL GEOMETRY TEST PRETEST/POSTTEST CORRELATIONS  
GEOMETRY INVESTIGATIONS A AND B

| Investigation A: |                                     | Investigation B: |                                     |
|------------------|-------------------------------------|------------------|-------------------------------------|
| Group            | Pretest/Posttest<br>Correlation (r) | Group            | Pretest/Posttest<br>Correlation (r) |
| A <sub>1</sub>   | .058                                | B <sub>1</sub>   | .541                                |
| A <sub>10</sub>  | .126                                | B <sub>10</sub>  | (-).066                             |
| A <sub>2</sub>   | .240                                | B <sub>2</sub>   | .075                                |

Use of a blocks by treatments design as an alternative to analysis of covariance to increase precision was considered impractical. Blocking of subjects would have resulted in elimination of some of the data from both geometry investigations.

Since statistical adjustment of the dependent variable, posttest achievement, was not a feasible approach to controlling pre-treatment differences between groups with the geometry data under study, it became important to establish pre-treatment equivalence of groups in geometry achievement.

Mathematically speaking, two normal distributions with equal means and standard deviations are identical.<sup>9</sup> When the means and standard deviations of samples match closely, we may feel reasonably sure that our samples are all representing the same thing [population].<sup>10</sup>

<sup>9</sup>N. M. Downie and R. W. Heath, Basic Statistical Methods (New York: Harper and Row, Publishers, 1965), p. 128.

<sup>10</sup>Henry E. Garrett, Statistics in Psychology and Education (New York: The David McKay Company, Inc., 1958), p. 205.

### Pre-Treatment Equivalence of Groups in Geometry

Complete pretest data for subjects in Geometry Investigations A and B are presented in Appendix E.

Pretest raw score group means for Geometry Investigation A were 11.81, 10.04, and 10.67 for Groups A<sub>1</sub>, A<sub>10</sub>, and A<sub>2</sub>, respectively. Standard deviations for group pretests were 3.40, 4.83, and 4.91

TABLE VIII  
SUMMARY OF GROUP PRETEST MEANS AND STANDARD DEVIATIONS  
GEOMETRY INVESTIGATIONS A AND B

| <u>Geometry Investigation A</u> |                            |                             |                            |
|---------------------------------|----------------------------|-----------------------------|----------------------------|
| <u>Characteristic</u>           | <u>Group A<sub>1</sub></u> | <u>Group A<sub>10</sub></u> | <u>Group A<sub>2</sub></u> |
| Pretest Mean                    | 11.81                      | 10.04                       | 10.67                      |
| Pretest Standard Deviation      | 3.40                       | 4.83                        | 4.91                       |

  

| <u>Geometry Investigation B</u> |                            |                             |                            |
|---------------------------------|----------------------------|-----------------------------|----------------------------|
| <u>Characteristic</u>           | <u>Group B<sub>1</sub></u> | <u>Group B<sub>10</sub></u> | <u>Group B<sub>2</sub></u> |
| Pretest Mean                    | 10.91                      | 10.67                       | 11.39                      |
| Pretest Standard Deviation      | 4.33                       | 3.28                        | 3.55                       |

Pretest raw score group means for Geometry Investigation B were 10.91, 10.67, and 11.39 for Groups B<sub>1</sub>, B<sub>10</sub>, and B<sub>2</sub>, respectively. Pretest standard deviations for the respective groups were 4.33, 3.28, and 3.55. A summary of these pretest data is shown in Table VIII.

The pretest variances of groups within each investigation were tested for homogeneity with the  $F_{\max}$  test.<sup>11</sup> The pretest variances of groups within each investigation were found not to differ significantly from each other at the .05 level of confidence as shown in Table IX.

<sup>11</sup>Edwards, op. cit., pp. 99-101.

TABLE IX

SUMMARY OF  $F_{\max}$  TESTS FOR HOMOGENEITY OF VARIANCE, PRETEST SCORES  
GEOMETRY INVESTIGATIONS A AND B

| Investigation A:                   |         | Investigation B:                   |           |
|------------------------------------|---------|------------------------------------|-----------|
| Groups                             | F Ratio | Groups                             | F Ratio   |
| A <sub>1</sub> vs. A <sub>10</sub> | 2.02*   | B <sub>1</sub> vs. B <sub>10</sub> | 1.75***   |
| A <sub>2</sub> vs. A <sub>10</sub> | 1.03*   | B <sub>2</sub> vs. B <sub>10</sub> | 1.18****  |
| A <sub>1</sub> vs. A <sub>2</sub>  | 2.09**  | B <sub>1</sub> vs. B <sub>2</sub>  | 1.49***** |

F ratios necessary for significance at the .05 level of confidence.

- \*2.42 with 23 and 20 degrees of freedom
- \*\*2.46 with 20 and 20 degrees of freedom
- \*\*\*2.45 with 21 and 20 degrees of freedom
- \*\*\*\*2.43 with 22 and 20 degrees of freedom
- \*\*\*\*\*2.38 with 21 and 22 degrees of freedom

Pretest means for groups within each investigation were tested for significance of difference using analysis of variance. The F ratio obtained from testing the means of groups in Investigation A was .90. The F ratio obtained from testing the means of groups in Investigation B was .21. Neither F ratio was significant at the .05 level of confidence, an F value of 3.14 being necessary to reject the null hypothesis at that level with two and sixty-three degrees of freedom. Source tables for the analysis of variance for pretest means in Geometry Investigations A and B are shown in Table X.

Since no significant differences were found to exist between the pretest means and variances of groups within either investigation, it could be stated that all groups within each investigation were equivalent groups, within the limits of random variation, prior to commencing the experimental treatment. It could then be inferred that any post-treatment differences in achievement found to exist between experimental and control groups within either investigation could be attributed to the experimental treatment.

TABLE X

SOURCE TABLES, ANALYSIS OF VARIANCE FOR PRETEST GROUP MEANS  
GEOMETRY INVESTIGATIONS A AND B

| <u>Geometry Investigation A</u> |                 |                    |             |         |
|---------------------------------|-----------------|--------------------|-------------|---------|
| Source                          | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
| Between Groups                  | 35.58           | 2.00               | 17.78       | .90*    |
| Within Groups                   | 1,250.86        | 63.00              | 19.85       |         |
| Total                           | 1,286.44        | 65.00              |             |         |
| <u>Geometry Investigation B</u> |                 |                    |             |         |
| Source                          | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
| Between Groups                  | 6.04            | 2.00               | 3.02        | .21*    |
| Within Groups                   | 885.96          | 63.00              | 14.06       |         |
| Total                           | 892.00          | 65.00              |             |         |

\*A critical value of 3.14 is required for significance at the .05 level of confidence with 2 and 63 degrees of freedom.

#### Report of Findings for Geometry Investigation A

Posttest raw score group means for groups in Geometry Investigation A were 26.24 for Group A<sub>1</sub>, 24.92 for Group A<sub>10</sub>, and 24.71 for Group A<sub>2</sub>. Standard deviations for the three groups were 6.62, 5.44, and 5.47, respectively. A summary of these data is shown in Table XI. Complete posttest achievement data for subjects in Geometry Investigation A are presented, by group, in Appendix E.

Posttest variances for the groups in Geometry Investigation A were tested for homogeneity using the  $F_{\max}$  test. The obtained F ratios for the three comparisons ranged from a low of 1.01 for Groups A<sub>2</sub> and A<sub>10</sub> to a high of 1.48 for A<sub>1</sub> and A<sub>10</sub> as shown in Table XII. None of the three obtained F ratios were significant at the .05 level of confidence.

TABLE XI  
SUMMARY OF POSTTEST MEANS AND STANDARD DEVIATIONS  
GEOMETRY INVESTIGATION A

| Characteristic              | Group A <sub>1</sub> | Group A <sub>10</sub> | Group A <sub>2</sub> |
|-----------------------------|----------------------|-----------------------|----------------------|
| Posttest Mean               | 26.24                | 24.92                 | 24.71                |
| Posttest Standard Deviation | 6.62                 | 5.44                  | 5.47                 |

Posttest data for Geometry Investigation A indicated that the experimental treatment did not have a significant effect on the spread of achievement within class groups.

TABLE XII  
SUMMARY OF  $F_{\max}$  TESTS FOR HOMOGENEITY OF VARIANCE, POSTTEST SCORES  
GEOMETRY INVESTIGATIONS A AND B

| Investigation A:                   |         | Investigation B:                   |           |
|------------------------------------|---------|------------------------------------|-----------|
| Groups                             | F Ratio | Groups                             | F Ratio   |
| A <sub>1</sub> vs. A <sub>10</sub> | 1.48*   | B <sub>1</sub> vs. B <sub>10</sub> | 1.46***   |
| A <sub>2</sub> vs. A <sub>10</sub> | 1.01*   | B <sub>2</sub> vs. B <sub>10</sub> | 1.20****  |
| A <sub>1</sub> vs. A <sub>2</sub>  | 1.46**  | B <sub>1</sub> vs. B <sub>2</sub>  | 1.21***** |

F ratios necessary for significance at the .05 level of confidence.

- \*2.36 with 20 and 23 degrees of freedom
- \*\*2.46 with 20 and 20 degrees of freedom
- \*\*\*2.45 with 21 and 20 degrees of freedom
- \*\*\*\*2.43 with 22 and 20 degrees of freedom
- \*\*\*\*\*2.38 with 21 and 22 degrees of freedom

Posttest means for groups in Investigation A were tested by analysis of variance to determine if differences in achievement had occurred between experimental groups and the control group as a result of the experimental treatment. It was found that the posttest means for these groups did not differ significantly at the .05 level of confidence. The resulting F ratio was .43. An F ratio of 3.14 is required for significance at that level of confidence with two and sixty-three degrees of freedom. The source table for the posttest test of significance for differences between means for Geometry Investigation A is shown in Table XIII.

TABLE XIII  
SOURCE TABLE: GEOMETRY INVESTIGATION A

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 29.16           | 2.00               | 14.58       | .43*    |
| Within Groups  | 2,155.93        | 63.00              | 34.22       |         |
| Total          | 2,185.09        | 65.00              |             |         |

\*A critical value of 3.14 is required for significance at the .05 level of confidence with 2 and 63 degrees of freedom.

The test data indicate that the experimental treatment did not affect the achievement of geometry pupils in Investigation A.

#### Report of Findings for Geometry Investigation B

Complete posttest achievement data for subjects in Geometry Investigation B are presented, by group, in Appendix E.

The posttest raw score group means for groups in Geometry Investigation B were 24.00 for Group B<sub>1</sub>, 22.00 for Group B<sub>10</sub>, and 21.48 for Group B<sub>2</sub>. The standard deviations for the three groups were 6.18, 5.12, and 5.62, respectively. A summary of posttest means and standard deviations for Geometry Investigation B is shown in Table XIV.



TABLE XIV  
SUMMARY OF POSTTEST MEANS AND STANDARD DEVIATIONS  
GEOMETRY INVESTIGATION B

| Characteristic              | Group B <sub>1</sub> | Group B <sub>10</sub> | Group B <sub>2</sub> |
|-----------------------------|----------------------|-----------------------|----------------------|
| Posttest Mean               | 24.00                | 22.00                 | 21.48                |
| Posttest Standard Deviation | 6.18                 | 5.12                  | 5.62                 |

Posttest variances for the groups in Geometry Investigation B were tested for homogeneity using the  $F_{\max}$  test. The F ratios for the three tests of significance ranged from 1.20 to 1.46 as shown in Table XII. None of the variance tests were significant at the .05 level of confidence.

On the basis of posttest data associated with Geometry Investigation B it could be stated that the experimental treatment did not have a significant effect on the spread of achievement within class groups.

Posttest means for groups in Investigation B were tested by analysis of variance to determine if differences in achievement had occurred between experimental groups and the control group as a result of the experimental treatment. The obtained F ratio of 1.23 was not significant with two and sixty-three degrees of freedom at the .05 level of confidence. An F value of 3.14 would have been required for rejection of the null hypothesis. The source table for the test of significance for differences between posttest means in Geometry Investigation B is shown in Table XV.

Posttest data for Geometry Investigation B indicate that the class period variable did not have an effect on the achievement of the pupils.

Hypothesis two stated that high school geometry pupils meeting in daily classes of 110 minutes for ninety days would not differ significantly in measurable cognitive learning achievement from similar pupils in geometry meeting in daily classes of 55 minutes for one hundred and eighty days. Since no significant differences were found between the posttest raw score means or variances in either Geometry Investigation A or Geometry Investigation B, the hypothesis of no difference could not be rejected.

TABLE XV

SOURCE TABLE: GEOMETRY INVESTIGATION B

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 78.75           | 2.00               | 39.37       | 1.23*   |
| Within Groups  | 2,019.74        | 63.00              | 32.06       |         |
| Total          | 2,098.49        | 65.00              |             |         |

\*A critical value of 3.14 is required for significance at the .05 level of confidence with 2 and 63 degrees of freedom.

## SUMMARY

This study tested for significance the differences between the cognitive learning achievement of pupils taking biology or geometry in classes meeting for ninety, 110-minute periods and those taking the same courses in classes meeting for one hundred and eighty, 55-minute periods. The research design included two investigations, A and B, for both biology and geometry. Investigation A in each course was a replication of the corresponding Investigation B in that course except that different teachers and different student subjects were used for each investigation. Chapter IV presents the findings relative to the differences in student achievement which were found in each investigation.

The only groups found to differ significantly in achievement following the experimental treatment were the two experimental groups, A<sub>1</sub> and A<sub>2</sub>, in Biology Investigation A. No statistically significant differences were found between the posttest means and variances of any control and experimental groups in any investigation.

On the basis of the data collected in this study it can be stated that the cognitive learning achievement of pupils taking biology or geometry in classes meeting in 110-minute class periods for ninety days does not differ from the cognitive learning achievement of similar pupils taking these courses in classes meeting in 55-minute class periods for one hundred and eighty days.

## CHAPTER V

### REPORT OF FINDINGS RELATIVE TO RETENTION

Hypotheses three and four addressed the questions of whether or not biology and geometry pupils who had taken those courses in ninety-day, 110-minute class periods retained what they had learned as well as pupils who had taken the courses in one hundred and eighty-day, 55-minute class periods. These hypotheses stated:

(1) That eight months following completion of the course, high school pupils in biology who had met in daily classes of 110 minutes for ninety days would not differ significantly in retention from similar pupils in biology who had met in daily classes of 55 minutes for one hundred and eighty days.

(2) That eight months following completion of the course, high school pupils in geometry who had met in daily classes of 110 minutes for ninety days would not differ significantly in retention from similar pupils in geometry who had met in daily classes of 55 minutes for one hundred and eighty days.

All surviving subjects who had completed biology or geometry were follow-up tested on the two hundred and forty-first day following the last day they had met in the class. Retention in biology was measured with the BSCS Green Version High School Biology Comprehensive Final Examination: Form L. Retention in geometry was measured with the Howell Geometry Test, Form A.

### EFFECTS OF CONTINUED STUDY ON RETENTION

All pupils who were follow-up tested during the 1971-72 school term were currently enrolled in school for that year. At the time of follow-up testing, several pupils were enrolled for Advanced Biology and/or Advanced Algebra and Trigonometry, the courses which normally followed Biology I and Plane and Solid Geometry, respectively, in the science and mathematics curricula at the cooperating high school. Other pupils had elected not to continue study in biological science or mathematics.

It was believed that if large differences existed between the numbers of experimental and control group pupils who had continued their studies in these disciplines, this fact might invalidate follow-up comparisons of retention. Therefore, prior to follow-up

testing, a count was made of research subjects who had continued to pursue studies in biology and mathematics during the year following their completion of the research classes.

Among biology class groups, Group A<sub>9</sub> had the smallest number and percentage of pupils who elected to continue in Advanced Biology with two pupils, or nine percent of the surviving class members. Four groups, A<sub>2</sub>, B<sub>1</sub>, B<sub>9</sub>, and B<sub>2</sub> had four pupils each who continued in Advanced Biology. Since Biology Group A<sub>2</sub> had a surviving membership of only nineteen pupils, that group had the largest percentage of the group continuing, twenty-one percent. Totally, only twenty-one of the one hundred and twenty-six surviving biology pupils elected to continue study in Advanced Biology. Enrollments in Advanced Biology are summarized, by groups, in Table XVI.

TABLE XVI  
NUMBERS AND PERCENTAGES OF PUPILS, BY GROUPS,  
CONTINUING STUDY IN ADVANCED BIOLOGY

| Class Group            | Number Taking<br>Advanced Biology | Number Not Taking<br>Advanced Biology | Percent of Class<br>Taking Adv. Biology |
|------------------------|-----------------------------------|---------------------------------------|---|
| Biology A <sub>1</sub> | 3                                 | 19                                    | 14%                                     |
| Biology A <sub>9</sub> | 2                                 | 21                                    | 9%                                      |
| Biology A <sub>2</sub> | 4                                 | 15                                    | 21%                                     |
| Biology B <sub>1</sub> | 4                                 | 17                                    | 19%                                     |
| Biology B <sub>9</sub> | 4                                 | 17                                    | 19%                                     |
| Biology B <sub>2</sub> | 4                                 | 16                                    | 20%                                     |
| Totals                 | 21                                | 105                                   | 17%                                     |

A greater number of pupils elected to continue study in mathematics than elected to continue study in biology. Overall, ninety-four of the one hundred and twenty-three surviving geometry pupils, or seventy-six percent, enrolled for Advanced Algebra and Trigonometry during the year following completion of the research class.

Geometry Group A<sub>1</sub> had eighteen pupils, or eighty-six percent of their surviving membership, who continued in Advanced Algebra and Trigonometry. Geometry Groups B<sub>1</sub> and B<sub>10</sub> had the smallest numbers of pupils continuing the study of mathematics with fourteen. Group B<sub>1</sub> had the smallest percentage of surviving members continuing with sixty-seven percent. Enrollments in Advanced Algebra and Trigonometry are summarized, by groups, in Table XVII.

TABLE XVII  
NUMBERS AND PERCENTAGES OF PUPILS, BY GROUP, CONTINUING  
STUDY IN ADVANCED ALGEBRA AND TRIGONOMETRY

| Class Group              | Number Taking<br>Adv. Alg. & Trig. | Number Not Taking<br>Adv. Alg. & Trig. | Percent of Class in<br>Adv. Alg. & Trig. |
|--------------------------|------------------------------------|--|--|
| Geometry A <sub>1</sub>  | 18                                 | 3                                      | 86%                                      |
| Geometry A <sub>10</sub> | 16                                 | 6                                      | 73%                                      |
| Geometry A <sub>2</sub>  | 15                                 | 4                                      | 79%                                      |
| Geometry B <sub>1</sub>  | 14                                 | 7                                      | 67%                                      |
| Geometry B <sub>10</sub> | 14                                 | 6                                      | 70%                                      |
| Geometry B <sub>2</sub>  | 17                                 | 3                                      | 85%                                      |
| Totals                   | 94                                 | 29                                     | 76%                                      |

ANALYSIS OF BIOLOGY RETENTION DATA:  
INVESTIGATIONS A AND B

Method of Data Analysis for Biology Retention

In order to be consistent with the method of data analysis used for testing differences in biology achievement, Chapter IV, analysis of covariance was used to test follow-up data for differences between group means. Posttest measures of achievement were used as the concomitant variables to adjust group means for follow-up tests comparing retention.

### Report of Findings for Biology Investigation A

Complete posttest and follow-up test data for subjects in Biology Investigation A are shown, by groups, in Appendix F.

After follow-up test group means were adjusted to account for posttest achievement, the adjusted group means were 23.36, 22.63, and 21.83 for Groups A<sub>1</sub>, A<sub>9</sub>, and A<sub>2</sub>, respectively. Posttest and follow-up test data for groups in Biology Investigation A are summarized in Table XVIII.

TABLE XVIII  
SUMMARY OF GROUP POSTTEST AND FOLLOW-UP TEST DATA  
BIOLOGY INVESTIGATION A

| Characteristic               | Group A <sub>1</sub> | Group A <sub>9</sub> | Group A <sub>2</sub> |
|------------------------------|----------------------|----------------------|----------------------|
| Posttest Mean                | 22.23                | 22.87                | 25.37                |
| Posttest Standard Deviation  | 6.07                 | 6.07                 | 6.35                 |
| Follow-Up Mean               | 22.64                | 22.30                | 23.05                |
| Follow-Up Standard Deviation | 6.23                 | 6.68                 | 5.95                 |
| Adjusted Follow-Up Mean      | 23.36                | 22.63                | 21.83                |

The F test for differences between adjusted group means in Investigation A produced an F ratio of .44 which was not significant at the .05 level of confidence as shown in Table XIX.

TABLE XIX  
SOURCE TABLE: FOLLOW-UP TESTS, BIOLOGY INVESTIGATION A

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 22.83           | 2.00               | 11.41       | .44*    |
| Within Groups  | 1,547.09        | 60.00              | 25.78       |         |
| Total          | 1,569.92        | 62.00              |             |         |

\*A critical value of 3.15 is required for significance at the .05 level of confidence with 2 and 60 degrees of freedom.

### Report of Findings for Biology Investigation B

Complete posttest and follow-up test data for subjects in Biology Investigation B are shown, by groups, in Appendix F.

After follow-up test group means were adjusted to account for posttest achievement, the adjusted group means were 22.85, 20.96, and 23.56 for Groups B<sub>1</sub>, B<sub>9</sub>, and B<sub>2</sub>, respectively. Posttest and follow-up test data for groups in Biology Investigation B are summarized in Table XX.

TABLE XX

#### SUMMARY OF GROUP POSTTEST AND FOLLOW-UP TEST DATA BIOLOGY INVESTIGATION B

| Characteristic               | Group B <sub>1</sub> | Group B <sub>9</sub> | Group B <sub>2</sub> |
|------------------------------|----------------------|----------------------|----------------------|
| Posttest Mean                | 25.14                | 23.66                | 23.90                |
| Posttest Standard Deviation  | 6.01                 | 5.71                 | 5.38                 |
| Follow-Up Mean               | 23.52                | 20.52                | 23.30                |
| Follow-Up Standard Deviation | 5.59                 | 5.94                 | 5.46                 |
| Adjusted Follow-Up Mean      | 22.85                | 20.96                | 23.56                |

The F test of significance for differences between adjusted group means in Investigation B produced an F ratio of 2.67 which was not significant at the .05 level of confidence. The source table for this F test is shown in Table XXI.

TABLE XXI

#### SOURCE TABLE: FOLLOW-UP TESTS, BIOLOGY INVESTIGATION B

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 74.50           | 2.00               | 37.25       | 2.67*   |
| Within Groups  | 809.46          | 58.00              | 13.96       |         |
| Total          | 883.96          | 60.00              |             |         |

\*A critical value of 3.16 is required for significance at the .05 level of confidence with 2 and 58 degrees of freedom.

Since no significant differences were found between the adjusted follow-up test means of the experimental groups and the control group in either biology investigation, A or B, research hypothesis three could not be rejected. It appears that taking biology in a class scheduled one hundred and ten minutes a day for ninety days instead of fifty-five minutes a day for one hundred and eighty days does not have an effect on the retention of learning in that course.

#### ANALYSIS OF GEOMETRY RETENTION DATA: INVESTIGATIONS A AND B

##### Method of Data Analysis for Geometry Retention

In order to be consistent with the method of data analysis used for geometry achievement in Chapter IV, analysis of variance was used to test follow-up test data for differences between group means.

##### Report of Findings for Geometry Investigation A

Complete follow-up test data for subjects in Geometry Investigation A are shown, by groups, in Appendix G.

Follow-up test group means for groups in Geometry Investigation A were 21.90 for Group A<sub>1</sub>, 20.82 for Group A<sub>10</sub>, and 20.37 for Group A<sub>2</sub> as shown in Table XXII. Follow-up test standard deviations for these three groups were 4.76, 5.67, and 5.73, respectively.

TABLE XXII

#### SUMMARY OF FOLLOW-UP TEST MEANS AND STANDARD DEVIATIONS GEOMETRY INVESTIGATION A

| Characteristic               | Group A <sub>1</sub> | Group A <sub>10</sub> | Group A <sub>2</sub> |
|------------------------------|----------------------|-----------------------|----------------------|
| Follow-Up Test Mean          | 21.90                | 20.82                 | 20.37                |
| Follow-Up Test Standard Dev. | 4.76                 | 5.67                  | 5.73                 |



The analysis of variance testing follow-up test group means in Investigation A for significance of difference produced a nonsignificant F ratio of .43. The source table for this test of significance is shown in Table XXIII.

TABLE XXIII

SOURCE TABLE: FOLLOW-UP TESTS, GEOMETRY INVESTIGATION A

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 25.34           | 2.00               | 12.67       | .43*    |
| Within Groups  | 1,719.51        | 59.00              | 29.14       |         |
| Total          | 1,744.85        | 61.00              |             |         |

\*A critical value of 3.15 is required for significance at the .05 level of confidence with 2 and 59 degrees of freedom.

Follow-up test variances for groups in Geometry Investigation A were tested for homogeneity with the  $F_{\max}$  test. The greatest F ratio, 1.44, resulted from testing the variances of Groups  $A_1$  and  $A_2$ . None of the F ratios were significant at the .05 level of confidence.

#### Report of Findings for Geometry Investigation B

Complete follow-up test data for subjects in Investigation B are shown, by groups, in Appendix G.

Follow-up test group means for Geometry Investigation B were 19.57 for Group  $B_1$ , 19.00 for Group  $B_{10}$ , and 19.65 for Group  $B_2$  as shown in Table XXIV. Follow-up test standard deviations for these groups were 6.53, 4.69, and 3.91, respectively.

The analysis of variance testing follow-up test group means in Investigation B for significance of differences produced a nonsignificant F ratio of .09. The source table for testing significance of differences between follow-up test means in Investigation B is shown in Table XXV.

TABLE XXIV  
SUMMARY OF FOLLOW-UP TEST MEANS AND STANDARD DEVIATIONS  
GEOMETRY INVESTIGATION B

| Characteristic               | Group B <sub>1</sub> | Group B <sub>10</sub> | Group B <sub>2</sub> |
|------------------------------|----------------------|-----------------------|----------------------|
| Follow-Up Test Mean          | 19.57                | 19.00                 | 19.65                |
| Follow-Up Test Standard Dev. | 6.53                 | 4.69                  | 3.91                 |

Follow-up test variances for groups in Geometry Investigation B were tested for homogeneity with the  $F_{\max}$  test. The comparison of variances for Group B<sub>1</sub> with Group B<sub>2</sub> produced a significant F ratio of 2.78, a critical value of 2.51 being necessary for significance at the .05 level of confidence with 20 and 19 degrees of freedom. No other tests for homogeneity of variance were significant at the .05 level of confidence.

TABLE XXV  
SOURCE TABLE: FOLLOW-UP TESTS, GEOMETRY INVESTIGATION B

| Source         | Sums of Squares | Degrees of Freedom | Mean Square | F Ratio |
|----------------|-----------------|--------------------|-------------|---------|
| Between Groups | 5.05            | 2.00               | 2.53        | .09*    |
| Within Groups  | 1,561.70        | 58.00              | 26.93       |         |
| Total          | 1,566.75        | 60.00              |             |         |

\*A critical value of 3.16 is required for significance at the .05 level of confidence with 2 and 58 degrees of freedom.

Since the significant variance difference was found between the two experimental groups rather than between an experimental

group and the control group, it must be assumed that any differences in the spread of follow-up test scores between groups in Investigation B was due to some factor other than the experimental length of class period.

#### SUMMARY

This study attempted to discover whether pupils taking biology or geometry in classes meeting one hundred and ten minutes daily for ninety days retained what they learned as well as similar pupils taking these courses in classes meeting fifty-five minutes daily for one hundred and eighty days. Tests for retention were given to all surviving pupils eight months after they completed the research class in biology and/or geometry.

Group means on the eight-month follow-up tests of achievement did not differ significantly at the .05 level of confidence in either course in either investigation.

One significant difference was found to exist between the follow-up test variances of two geometry groups in Investigation B. However, the significant difference was found between variances of experimental groups B<sub>1</sub> and B<sub>2</sub> rather than between one of the experimental groups and the control group.

On the basis of the follow-up test data collected in this study, it can be stated that pupils' retention of what they learn in biology or geometry is not affected when they take these courses in ninety, 110-minute class periods instead of one hundred and eighty, 55-minute class periods.

## CHAPTER VI

### REPORT OF FINDINGS RELATIVE TO SCHEDULING PREFERENCES OF PUPILS

The relevance of educational programs is being questioned by college and secondary school students with increasing frequency. The trend appears to be toward giving high school pupils a greater voice in program planning. Therefore, when any break with scholastic tradition is undertaken, data concerning the acceptance or rejection of that change by the pupils becomes highly important.

This chapter reports the findings of this study which pertain to: (1) the preferences of pupils for each kind of class schedule under study, and (2) the reasons given by pupils for their preferences. Hypotheses 5-A, 5-B, 5-C, and 5-D considered pupil preferences for the long-block-of-time class period compared to their preferences for the traditional class period. Data relative to these hypotheses were collected from Part I of the Student Preference Opinionnaire on the Allocation of Class Time. Part II of the opinionnaire sought to identify the reasons given by pupils for preferring the long-block-of-time class period. Part III sought to identify the reasons given by pupils for preferring the traditional class period. This opinionnaire is exhibited in Appendix B.

The opinionnaire was given only to pupils in experimental groups because control group pupils had not experienced instruction in the long-block-of-time class. The opinionnaire was completed by pupils on the last day they attended the long-block-of-time class.

#### FINDINGS RELATIVE TO HYPOTHESIS 5-A

Hypothesis 5-A expressed an expectation that no significant difference would be found between the numbers of experimental group pupils who preferred the long-block-of-time class schedule and those who preferred the traditional class schedule.

The data failed to support this hypothesis. A sizable majority (63.2%) of the pupils responding to the opinionnaire preferred the long-block-of-time class period over the traditional class period. A lesser number (23.6%) stated no preference for one kind of class period over the other. Only a few (13.2%) said they preferred the traditional one hundred and eighty-day, 55-minute class period. Preferences stated by pupils are shown in Table XXVI.

# SUMMARY OF RESPONSES TO THE STUDENT OPINIONNAIRE ON THE ALLOCATION OF CLASS TIME, PART I

TABLE XXVI

| INSTRUCTOR AND PREFERENCE                 | FIRST SEMESTER | SECOND SEMESTER | TOTAL, BOTH SEMESTERS |
|---|----------------|-----------------|-----------------------|
| <u>Biology Teacher A</u>                  |                |                 |                       |
| Prefer the 90-day/110-minute class period | 18 (81.8%)     | 15 (78.9%)      | 33 (80.5%)            |
| Prefer the 180-day/55-minute class period | 0 ( 0.0%)      | 2 (10.5%)       | 2 ( 4.9%)             |
| No preference                             | 4 (18.2%)      | 2 (10.5%)       | 6 (14.6%)             |
| <u>Biology Teacher B</u>                  |                |                 |                       |
| Prefer the 90-day/110-minute class period | 12 (52.2%)     | 8 (34.8%)       | 20 (43.5%)            |
| Prefer the 180-day/55-minute class period | 4 (17.4%)      | 7 (30.4%)       | 11 (23.9%)            |
| No preference                             | 7 (30.4%)      | 8 (34.8%)       | 15 (32.6%)            |
| <u>Geometry Teacher A</u>                 |                |                 |                       |
| Prefer the 90-day/110-minute class period | 19 (90.5%)     | 16 (76.2%)      | 35 (83.3%)            |
| Prefer the 180-day/55-minute class period | 1 ( 4.8%)      | 1 ( 4.8%)       | 2 ( 4.8%)             |
| No preference                             | 1 ( 4.8%)      | 4 (19.0%)       | 5 (11.9%)             |
| <u>Geometry Teacher B</u>                 |                |                 |                       |
| Prefer the 90-day/110-minute class period | 14 (60.9%)     | 8 (36.4%)       | 22 (48.9%)            |
| Prefer the 180-day/55-minute class period | 1 ( 4.3%)      | 7 (31.8%)       | 8 (17.8%)             |
| No preference                             | 8 (34.8%)      | 7 (31.8%)       | 15 (33.3%)            |
| <u>Total, All Subjects in All Classes</u> |                |                 |                       |
| Prefer the 90-day/110-minute class period | 63 (70.8%)     | 47 (55.3%)      | 110 (63.2%)           |
| Prefer the 180-day/55-minute class period | 6 ( 6.7%)      | 17 (20.0%)      | 23 (13.2%)            |
| No preference                             | 20 (22.5%)     | 21 (24.7%)      | 41 (23.6%)            |

When data on scheduling preferences were compared, using the chi square technique, with a hypothetical population having no difference in scheduling preferences, a  $X^2$  value of 72.72 was obtained. This value was highly significant at the .01 level of confidence, a  $X^2$  value of 9.21 being necessary for rejection of the null hypothesis at that level. The hypothesis of no difference in scheduling preferences among pupils in the study was not accepted. The data from this study indicate that pupils have a strong preference for the long-block-of-time class period over the traditional class period.

#### FINDINGS RELATIVE TO HYPOTHESIS 5-B

Hypothesis 5-B stated that no significant difference would be found between the scheduling preferences of pupils taking the same courses under different teachers.

Data showing the scheduling preferences of pupils taking the same courses under different teachers are presented in Table XXVII.

A chi square comparison of scheduling preferences between pupils taught by Biology Teacher A and those taught by Biology Teacher B produced a  $X^2$  value of 13.03. A comparison of scheduling preferences between pupils of Geometry Teacher A and Geometry Teacher B produced a  $X^2$  value of 11.48. The chi square values for both comparisons were significant at the .01 level of confidence. Hypothesis 5-B was not accepted.

It appeared that there were factors present in the combination of different teachers with the long-block-of-time class period which affected the preferences of the pupils for such a schedule. However, it can be noted that both the biology and geometry pupils with the teachers in Investigation A strongly favored the long-block-of-time class period (80.5% and 83.3%, respectively). In Investigation B more pupils in both biology and geometry preferred the long-block-of-time class period (43.5% and 48.9%, respectively) than preferred the traditional class schedule (23.9% and 17.8%, respectively). However, the preferences of pupils in Investigation B for the long-block-of-time class schedule were not as strong as they were in Investigation A. Other characteristics of the pupils assigned to each investigation, rather than the combination of teacher with class time, may have caused the difference in scheduling preferences found between groups in the two investigations.

TABLE XXVII

COMPARISON OF SCHEDULING PREFERENCES OF PUPILS  
BY TEACHERS WITHIN EACH COURSE AREA

Biology Groups A and B

Biology Teacher A:

|   |            |
|---|------------|
| Prefer the 90-day/110-minute class period . . . . . | 33 (80.5%) |
| Prefer the 180-day/55-minute class period . . . . . | 2 ( 4.9%)  |
| No preference . . . . .                             | 6 (14.6%)  |
| N = . . . . .                                       | 41         |

Biology Teacher B:

|   |            |
|---|------------|
| Prefer the 90-day/110-minute class period . . . . . | 20 (43.5%) |
| Prefer the 180-day/55-minute class period . . . . . | 11 (23.9%) |
| No preference . . . . .                             | 15 (32.6%) |
| N = . . . . .                                       | 46         |

Biology Teacher A vs. Biology Teacher B,  $X^2 = 13.03$

Geometry Groups A and B

Geometry Teacher A:

|   |            |
|---|------------|
| Prefer the 90-day/110-minute class period . . . . . | 35 (83.3%) |
| Prefer the 180-day/55-minute class period . . . . . | 2 ( 4.8%)  |
| No preference . . . . .                             | 5 (11.9%)  |
| N = . . . . .                                       | 42         |

Geometry Teacher B:

|   |            |
|---|------------|
| Prefer the 90-day/110-minute class period . . . . . | 22 (48.9%) |
| Prefer the 180-day/55-minute class period . . . . . | 8 (17.8%)  |
| No preference . . . . .                             | 15 (33.3%) |
| N = . . . . .                                       | 45         |

Geometry Teacher A vs. Geometry Teacher B,  $X^2 = 11.48$

Significant  $X^2$  value at .01 level of confidence is 9.21

## FINDINGS RELATIVE TO HYPOTHESIS 5-C

Hypothesis 5-C expressed an expectation that no significant difference would be found between the scheduling preferences of pupils in geometry and those in biology.

When the scheduling preferences of biology pupils were compared to those of geometry pupils, the obtained  $\chi^2$  value of .56 was not significant at the .01 level of confidence. The hypothesis of no difference could not be rejected. Data related to hypothesis 5-C are presented in Table XXVIII.

TABLE XXVIII  
COMPARISON OF SCHEDULING PREFERENCES OF PUPILS  
BY COURSE AREA

| <u>Biology</u>  |                  |
|---|------------------|
| Prefer the 90-day/110-minute class period                     |                  |
| Teacher A (33) + Teacher B (20) . . . . .                     | 53 (60.9%)       |
| Prefer the 180-day/55-minute class period                     |                  |
| Teacher A (2) + Teacher B (11) . . . . .                      | 13 (15.0%)       |
| No preference   |                  |
| Teacher A (6) + Teacher B (15) . . . . .                      | 21 (24.1%)       |
|   | N = . . . . . 87 |
| <u>Geometry</u>   |                  |
| Prefer the 90-day/110-minute class period                     |                  |
| Teacher A (35) + Teacher B (22) . . . . .                     | 57 (65.5%)       |
| Prefer the 180-day/55-minute class period                     |                  |
| Teacher A (2) + Teacher B (8) . . . . .                       | 10 (11.5%)       |
| No preference   |                  |
| Teacher A (5) + Teacher B (15) . . . . .                      | 20 (23.0%)       |
|   | N = . . . . . 87 |
| Biology vs. Geometry, $\chi^2 = .56$                          |                  |
| Significant $\chi^2$ value at .01 level of confidence is 9.21 |                  |



Based on the scheduling preferences expressed by pupils in the study, the long-block-of-time class period appeared to be equally acceptable for geometry classes and for biology classes.

#### FINDINGS RELATIVE TO HYPOTHESIS 5-D

Hypothesis 5-D stated that no significant difference would be found between the scheduling preferences of pupils enrolled in long-block-of-time classes for the first time, first semester pupils, and those enrolled the second time, second semester pupils. Underlying hypothesis 5-D was the supposition that if the Hawthorne effect of the experimental class period were responsible for pupils preferring the long-block-of-time class period, their preference for the schedule would decline after they had become accustomed to this kind of class period.

Scheduling preferences stated by pupils who had completed their first experience with the long-block-of-time, first semester pupils, were compared with those of pupils who had completed their second long-block-of-time class, second semester pupils. The data presented in Table XXIX show that there was a shift away from preference for the long-block-of-time after pupils had experienced a second one-semester class under this scheduling plan. However, the shift was not so great that it could not be attributed to chance, alone. The chi square value obtained when preferences of first semester pupils were compared to those of second semester pupils was 7.52. A chi square value  $\geq 9.21$  was necessary to reject the null hypothesis at the .01 level of confidence.

Examination of the data presented in Table XXVI revealed that some loss of preference for the long-block-of-time class period occurred under all four teachers and in both courses involved in the study. The shift in preference away from the long-block-of-time schedule was more pronounced among pupils in Investigation B than among those in Investigation A. This fact may have been an indication that shifts in scheduling preferences of the pupils were influenced by the teacher with whom they were scheduled.

The degree to which the scheduling preferences of biology pupils shifted away from favoring the long-block-of-time schedule was quite similar to the shifting of preferences among geometry pupils. Apparently any change in the scheduling preferences of the pupils was unrelated to the course being taken.

TABLE XXIX  
COMPARISON OF SCHEDULING PREFERENCES OF PUPILS  
BY SEMESTERS

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| <u>First Semester Preferences</u>                   |                  |
|---|------------------|
| Prefer the 90-day/110-minute class period . . . . . | 63 (70.8%)       |
| Prefer the 180-day/55-minute class period . . . . . | 6 ( 6.7%)        |
| No preference . . . . .                             | 20 (22.5%)       |
|   | N = . . . . . 89 |

| <u>Second Semester Preferences</u>                  |                  |
|---|------------------|
| Prefer the 90-day/110-minute class period . . . . . | 47 (55.3%)       |
| Prefer the 180-day/55-minute class period . . . . . | 17 (20.0%)       |
| No preference . . . . .                             | 21 (24.7%)       |
|   | N = . . . . . 85 |

First Semester vs. Second Semester,  $X^2 = 7.52$

Significant  $X^2$  value at .01 level of confidence is 9.21

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REASONS GIVEN BY PUPILS FOR PREFERRING THE  
LONG-BLOCK-OF-TIME CLASS PERIOD

Part II of the Student Preference Opinionnaire on the Allocation of Class Time was completed by those experimental group pupils who had either expressed a preference for the long-block-of-time class, or had expressed no preference for one type of class period over the other in Part I. Those respondents were given a list of six reasons why they might have found the long-block-of-time class period appealing. Each was instructed to place a check to the left of each listed reason which they agreed was an important advantage of the long class schedule. Respondents were also asked to add in writing any other reasons they might have had for preferring the long-block-of-time class period.

In Part I a total of one hundred and ten pupils expressed a preference for the long-block-of-time class period; forty-one expressed no preference for one schedule over the other; making a total of one hundred and fifty-one pupils who responded to Part II of the opinionnaire as shown in Table XXVI.

The six reasons for preferring the long-block-of-time schedule which were included in Part II have been presented in Table XXX. The table also displays the total number of respondents selecting each reason and the percentage of total respondents choosing that reason. One other reason for preferring the experimental class schedule appeared in the unrestricted written responses with sufficient frequency to justify including it in Table XXX. This reason was listed as item seven (7) in Table XXX.

More than one-half of those pupils responding to Part II reported they liked the long-block-of-time class period for reasons related to learning--maintaining interest and motivation, and making more progress in learning. Seventy-seven percent said that having fewer courses helped them stay more interested in the subject. Seventy-one percent said they liked the variety of learning activities made possible by the longer class period. Sixty-three percent stated the subject moved faster and was more unified under the long period, and fifty-six percent expressed a belief that the faster pace contributed to more intense concentration on the subject and led to more thorough learning.

Fewer than one-half of those responding recognized any merit in the long-block-of-time class insofar as it offered a better opportunity for improved pupil-teacher relationships. Forty-four percent stated they thought the longer class period helped teachers and pupils get to know and understand each other better. Only about one respondent in three, thirty-six percent, said the teacher's reduced class load helped the teacher to better know and understand his pupils.

When the unrestricted written reasons for preferring the long-block-of-time class period were considered, it was found that several were merely restatements of the reasons already given in the checklist. These restatements were eliminated from consideration. Close comparison of the remaining eighty-four written statements revealed that many had enough similarity of intent to defend clustering them into ten summary statements. These ten summary statements are shown in Table XXXI along with the number and percentage of pupils making each kind of response.

The only unrestricted written comments which appeared on more than ten percent of the opinionnaires referred to a reduction in homework and out-of-class study as an advantage of the long-block-of-

TABLE XXX  
REASONS GIVEN BY EXPERIMENTAL GROUP PUPILS FOR PREFERRING  
THE LONG-BLOCK-OF-TIME CLASS PERIOD

| CHECKLIST REASON  | NUMBER<br>AGREEING | PERCENTAGE<br>AGREEING |
|---|--------------------|------------------------|
| 1. I feel I can stay more interested in the subject when I have fewer subjects at a time to divide my attention.  | 116                | 77%                    |
| 2. I feel that more intense concentration on the subject enables me to learn that subject more thoroughly.  | 84                 | 56%                    |
| 3. Having a longer period of time each day enables the class to participate in a greater variety of learning activities.  | 107                | 71%                    |
| 4. A longer period of daily contact between the student and the teacher helps us to get to know and understand each other better.   | 67                 | 44%                    |
| 5. The teacher knows and understands me better because he/she has fewer students each day to get to know.   | 54                 | 36%                    |
| 6. I find that in the longer period of time each day the subject moves faster and it helps me tie various fragments of the subject together into a more meaningful whole. | 95                 | 63%                    |
| 7. The amount of out-of-class study and homework is reduced in the one semester double-period block-of-time class.<br>(From unrestricted written responses, Table XXXI)   | 49                 | 32%                    |
| Total Number of Respondents = 151   |                    |                        |

TABLE XXXI

SUMMARY OF UNRESTRICTED WRITTEN REASONS GIVEN BY  
EXPERIMENTAL GROUP PUPILS FOR PREFERRING  
THE LONG-BLOCK-OF-TIME CLASS PERIOD

| SUMMARY STATEMENT OF REASON  | NUMBER<br>OF<br>RESPONSES | PERCENTAGE<br>OF TOTAL<br>RESPONDENTS |
|--|---------------------------|---------------------------------------|
| 1. The amount of out-of-class study and homework is reduced in the one-semester double-period block-of-time class (See Table XXX). | 49                        | 32%                                   |
| 2. I like to "get a class over with" and start a new class at the semester.  | 10                        | 7%                                    |
| 3. Teachers have more time to give individual help and to explain difficult concepts.  | 6                         | 4%                                    |
| 4. Classes can start and finish laboratory experiments within the one class period.  | 5                         | 3%                                    |
| 5. We seem to "get more done" in the double-period block class.  | 3                         | 2%                                    |
| 6. Classes in double-period blocks are more interesting and/or enjoyable.  | 3                         | 2%                                    |
| 7. Time seems to go faster in the double-period block class.   | 3                         | 2%                                    |
| 8. The number of semester examinations is reduced by one.  | 2                         | 1%                                    |
| 9. Students get to know the other students in their classes better.  | 2                         | 1%                                    |
| 10. Teachers use their time more effectively in the double-period block class.   | 1                         | 1%                                    |

time class period. Forty-nine pupils, or thirty-eight percent of those responding, recognized this as a desirable feature of the long class period. Closer examination of these written statements indicated that pupils attributed this reduction in out-of-class study to two factors. First, they expressed a belief that teachers allowed more time for inclass supervised study in the ninety-day, 110-minute class than they did in the one hundred and eighty-day, 55-minute class. Second, pupils stated that taking one less course as a result of doubling the period and completing the course in one semester reduced the number of different preparations with which they had to be concerned.

#### REASONS GIVEN BY PUPILS FOR PREFERRING THE TRADITIONAL CLASS PERIOD

Part III of the Student Preference Opinionnaire on the Allocation of Class Time was completed by those experimental group pupils who either expressed a preference for the traditional one hundred and eighty-day, 55-minute class period, or expressed no preference for one kind of schedule over the other in Part I. Respondents to this section of the opinionnaire were given a list of four reasons why they might have found the long-block-of-time class to be undesirable. They were instructed to place a check to the left of each listed reason which they agreed was a factor in their preferring the traditional class schedule. Respondents to this section were also asked to add in writing any other features of the long-block-of-time schedule which they had found to be undesirable.

In Part I, a total of twenty-three pupils expressed a preference for the traditional class schedule; forty-one expressed no preference for one type of schedule over the other; making a total of sixty-four pupils who responded to Part III of the opinionnaire as shown in Table XXVI.

The four reasons given in Part III for preferring the traditional class schedule are presented in Table XXXII. Each reason is presented with the total number of responses and the percentage of total respondents to Part III who agreed with that reason.

About six of every ten pupils responding to Part III, fifty-nine percent, stated they did not like the long-block-of-time class period because they thought the longer period contributed to their loss of interest in the subject. A similar number said the double-period-block class moved so rapidly that they could not learn the subject as thoroughly as in the traditional class period.

As in Part II, pupils responding to Part III appeared to attach more importance to factors related to their learning than

TABLE XXXII

REASONS GIVEN BY EXPERIMENTAL GROUP PUPILS FOR NOT  
PREFERRING THE LONG-BLOCK-OF-TIME CLASS PERIOD

| CHECKLIST REASON   | NUMBER<br>AGREEING | PERCENTAGE<br>AGREEING |
|--|--------------------|------------------------|
| 1. I lose interest in the subject when I have to concentrate too long.   | 38                 | 59%                    |
| 2. I feel we cover the subject matter so rapidly in the 110-minute/90-day class that I do not have a chance to learn the subject as thoroughly as I do in the 55-minute/180-day class. | 38                 | 59%                    |
| 3. I find that when I spend a longer period of time with the same teacher each day we get on each other's nerves.  | 11                 | 17%                    |
| 4. Taking more subjects makes school more interesting.   | 13                 | 20%                    |
| 5. The class gets boring when I have to sit in it two periods in a row. (From Unrestricted Written Responses, Table XXXIII).   | 12                 | 19%                    |

Total Number of Respondents = 64

they did factors related to personal feelings or personal relationships. Only one pupil in five stated that taking more courses at one time added to their interest in school. An even smaller number, seventeen percent, said their personal relationship with the teacher was adversely affected by the longer time they spent together in class.

One unrestricted written comment appeared in Part III with enough frequency to justify including it in Table XXXII as a major disadvantage of the double-period-block class. Twelve pupils, or nineteen percent of those responding to Part III, mentioned developing feelings of boredom when they were required to sit through a class period of double length. In reporting these findings consideration was given to the similarity between these comments and checklist item one (1) which referred to a "loss of interest" when students were required to concentrate on the subject for too long a period of time. It was finally concluded that even though the intent of some respondents who reported feelings of boredom may have been similar to the intent of checklist item one (1), no misunderstanding would result from reporting these written references to boredom as a separate response.

When the unrestricted written reasons for not preferring the long-block-of-time class period were considered, it was found that only five had to be eliminated because they were restatements of checklist items in Part III. The remaining thirty statements were then compared for similarity of content. It was found they could be combined into eleven summary statements. These summary statements are reported in Table XXXIII with the number of responses and the percentage of total respondents for each.

With the exception of statements referring to boredom resulting from being required to sit in class for too long a period at one time, no other written reason for disliking the long-block-of-time class appeared on as many as ten percent of the opinionnaires.

#### SUMMARY

Analysis of data collected on the Student Preference Opinionnaire on the Allocation of Class Time revealed that a significant majority of the pupils who completed a class under the ninety-day, 110-minute period schedule preferred this type of schedule over the traditional one hundred and eighty-day, 55-minute period schedule.

The preferences of pupils for the experimental class schedule appeared to be affected by the teacher. There was a significant



TABLE XXXIII

SUMMARY OF UNRESTRICTED WRITTEN REASONS GIVEN BY EXPERIMENTAL GROUP  
PUPILS FOR PREFERRED THE TRADITIONAL CLASS PERIOD

| SUMMARY STATEMENT OF REASON   | NUMBER<br>OF<br>RESPONSES | PERCENTAGE<br>OF TOTAL<br>RESPONDENTS |
|---|---------------------------|---------------------------------------|
| 1. The class gets boring when pupils have to sit in it two periods at a time.                                 | 12                        | 19%                                   |
| 2. Having more classes helps me become acquainted with more of the other pupils.                              | 4                         | 6%                                    |
| 3. It is easier to learn the subject in shorter class periods because the pace is slower.                     | 3                         | 5%                                    |
| 4. We do not cover as much material in the two-period block class.  | 2                         | 3%                                    |
| 5. It pushes me harder to keep up with my homework in the double-period block class.                          | 2                         | 3%                                    |
| 6. Because of the one-semester time lapse between courses I may forget too much before taking the next class. | 2                         | 3%                                    |
| 7. More time is wasted in the double-period class than in the single-period class.                            | 1                         | 2%                                    |
| 8. Tests come more frequently in the double-period class.   | 1                         | 2%                                    |
| 9. Teachers cannot give as long a test in one period as they can in two periods.                              | 1                         | 2%                                    |
| 10. I could not stand to be in a class I didn't like for two periods straight.                                | 1                         | 2%                                    |
| 11. It is better to have a teacher I don't like for one period a day than for two.                            | 1                         | 2%                                    |

difference in the proportion of preferences for each kind of class schedule between pupils taking the same courses under different teachers.

No significant difference was found between the proportion of biology pupils and the proportion of geometry pupils who preferred the long-block-of-time class period. Apparently the experimental class schedule was equally appealing to both biology and geometry pupils.

A drop in preference for the long-block-of-time class period occurred after pupils had experienced it for two semesters. This decline in preference from first semester to second semester occurred in all classes. It was more pronounced among pupils in Investigation B than among those in Investigation A. However, the overall shift in preference was not statistically significant at the .01 level of confidence.

Among pupils who preferred the long-block-of-time class period and those who had no preference, a majority said they liked the experimental schedule because it helped them stay more interested in the course, it made a greater variety of learning activities possible, the course seemed to move faster and to have more unity, and they thought they learned the subject matter more thoroughly. Less than one-half of those pupils stated it improved opportunities for increased understanding and a better personal relationship between teachers and pupils. Several of those pupils expressed a belief that the out-of-class study load was lighter under the long-block-of-time schedule than it was under the traditional class schedule.

Among pupils who preferred the traditional class period and those who had no preference, over one-half stated that the long-block-of-time class period caused them to lose interest in the subject because they had to concentrate on it too long at a time. A majority also said they moved through the course so rapidly in the long-period class that they didn't have time to learn it thoroughly. However, only one-fifth of those pupils said the opportunity to take more courses under the traditional class schedule made school more interesting. An even smaller number stated the length of time in class each day contributed to conflicts between teachers and pupils. Pupils responding to this section also frequently cited boredom from sitting in class too long as a disadvantage to the long-block-of-time class period.

## CHAPTER VII

### REPORT OF OBSERVATIONS OF TEACHERS RELATIVE TO LENGTH OF CLASS PERIOD

During the course of the study project teachers recorded their observations of certain strengths and weaknesses of the experimental class period. A summary of these observations is reported in this chapter.

Project teachers maintained a daily log of class activities. The log included a daily lesson plan sheet, a daily evaluation of instruction in both experimental and control class groups, and a unit summary evaluation of instruction in both kinds of groups. Daily log record sheets are exhibited in Appendix A.

At the end of the school year, project teachers prepared a written summary of their observations based on the data recorded in their log records. Teachers were asked, specifically, to report their observations regarding the following questions:

1. What effect did the long-block-of-time class period have on the attention span of pupils?
2. What effect did the long-block-of-time class period have on the motivation of pupils?
3. What effect did the long-block-of-time class period have on the rate at which pupils were able to master the subject matter being covered?
4. What modifications in teaching methods were found to be necessary or desirable in adjusting instruction to the long-block-of-time class period?
5. What effect did the long-block-of-time class period have on the classroom conduct of pupils?
6. What were the teachers' assessments of pupil reaction to the long-block-of-time class period?

In addition to responding to these specific questions, project teachers were asked to report, without restriction, any other advantages or disadvantages they had found to the long-block-of-time class period.

### ATTENTION SPAN OF PUPILS

None of the four teachers reported any difficulty in holding the attention of pupils in the long-block-of-time class period as long as classroom activities were changed from time to time during each period. No teacher reported an optimal number of changes in activity. Two teachers stated that better planning of activities was required to hold the attention of pupils in the experimental class period than was required in the traditional class period.

### MOTIVATION OF PUPILS

Three of the four teachers reported that motivation of pupils was less of a problem in the long-block-of-time period than in the traditional class period. However, none of those teachers wanted to attribute the better motivation of experimental class groups to the extended class period. All stated they believed it to be a result of the personalities of students who chanced to be assigned to these classes rather than a function of class period length. The fourth teacher stated that the length of class period did not affect the motivation of pupils.

### MASTERY OF SUBJECT MATTER

Three of the four teachers reported that the long-block-of-time class period did not have an adverse effect on the mastery of subject matter by pupils. The evaluation of pupil achievement, reported in Chapter IV, supported this observation. The fourth teacher stated that pupils found it harder to master some of the more difficult concepts in the long period because the class was moving at an accelerated daily pace. This teacher observed that mastery of difficult concepts in the long-block-of-time class schedule was particularly troublesome for the less able pupil.

### MODIFICATION OF TEACHING METHODS

The basic methods of instruction used in experimental and control groups were held constant as part of the experimental design. All four teachers reported that they had not found it necessary to vary learning activities during the long-block-of-time period as often as they had first thought it would be. Two teachers did say it was necessary to vary learning activities more often than

in the traditional class period. One teacher, after experimentation with varying the numbers of learning activities each period, finally reported that it was most satisfactory to organize activities in the one hundred and ten minute class as if it were two fifty-five minute classes.

#### CLASSROOM CONDUCT OF PUPILS

None of the four teachers reported pupil conduct in long-block-of-time classes to be worse than it was in their fifty-five minute classes. The two teachers in Investigation A reported more problems with pupil conduct in their control group class. However, they expressed the opinion that this was due to a difference in the personalities of the pupils rather than a result of the time variable.

#### TEACHER ASSESSMENT OF PUPILS' REACTION

None of the four teachers observed any major dissatisfaction among the pupils with the long-block-of-time class period. Responses of pupils to the Student Preference Opinionnaire on the Allocation of Class Time supported these observations.

#### OTHER ADVANTAGES TO EXTENDED PERIODS

Among other advantages to the long-block-of-time class period reported by project teachers, three of the four said: (1) the longer period gave them more freedom in planning daily instructional activities, (2) it gave the teacher an opportunity to immediately reinforce with practice concepts which had just been taught, (3) it gave the teacher a better opportunity to identify and give additional help to pupils having difficulty, and (4) it helped some pupils by reducing by one the number of courses they were taking at one time.

Both biology teachers expressed satisfaction with the long period because it gave them time to initiate and carry through to completion most of their laboratory exercises in a single class day. They also reported that the long period offered a better opportunity for field trips and the use of resource people.

Two teachers said the longer period increased the opportunity for supervised study in class and reduced the amount of unsupervised

homework. Two also reported that the longer period of daily contact with pupils gave them a chance to get better acquainted with their pupils and to establish better rapport with them.

Other advantages reported by only one teacher were: (1) it forced the teacher to plan more thoroughly and to organize material better, (2) it made the teacher learn to economize on class time and delete nonessential material, (3) it allowed pupils who worked slowly time to complete examinations, and (4) it had potential to provide a more flexible schedule for pupils.

#### OTHER DISADVANTAGES TO EXTENDED PERIODS

The most serious disadvantage of the long-block-of-time period reported by teachers was concerned with pupil absenteeism. All four teachers stressed the fact that pupils who missed one day of school under the double-period schedule fell twice as far behind as pupils absent one day under the single-period schedule. The extra make-up work placed an additional burden on both teachers and pupils.

Three teachers said they had found the long-block-of-time class period placed more demands on planning by the teacher.

A disadvantage cited by both biology teachers concerned the necessity of assembling laboratory materials twice a year instead of once. This appeared to be a special problem with live specimens. Two teachers also said the long-period class complicated the ordering of films. The accelerated daily pace of instruction forced them to be more precise in scheduling and ordering instructional films.

Two teachers reported that they covered less material in their long-block-of-time classes than in their traditional classes. They attributed this to two factors: (1) their experimental classes were interrupted more frequently by such activities as assembly programs and early dismissals, and (2) when pupil interest in a topic was high, they found it difficult to terminate discussion of the topic at the end of the first period in the double-period class. The dismissal bell forced termination of such discussion in the single-period class.

Two teachers reported complications they had encountered with computerized grade reporting as a result of having to report a semester grade at the end of forty-five days and a final grade at the end of ninety days in the long-block-of-time class.

One teacher reported that pupils in the double-period class did not get to spend enough days on the more difficult concepts to allow them time to "soak in."

## SUMMARY

Teachers did not find that the long-block-of-time class period created difficulties in holding the attention of pupils as long as classroom activities were varied.

Teachers did not find that the long-block-of-time class period was detrimental to the motivation of pupils.

Teachers, generally, did not think the long-block-of-time class period had any adverse effect on students' mastery of the subject matter.

Little or no modification in methods of instruction was found to be necessary or desirable in adapting instruction to the long-block-of-time class period.

Teachers did not find that the long-block-of-time class period contributed to pupil misconduct in the classroom.

Teachers, generally, observed that pupils had favorable attitudes toward the long-block-of-time class period.

In summary, both mathematics teachers and one of the biology teachers concluded that as a result of their experience they preferred the one hundred and ten-minute, ninety-day class schedule for their classes. The other biology teacher expressed serious reservations about the appropriateness of this kind of schedule for high school biology classes.

## CHAPTER VIII.

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

#### SUMMARY DESCRIPTION OF THE STUDY

Secondary schools are departing with increasing frequency from traditional class schedules with six to eight periods of forty to sixty minutes duration. Few research findings have been reported to guide school administrators in making decisions about the optimal amount of daily class time to allocate to courses in the secondary school schedule.

The purposes of this study were: (1) to determine if the cognitive learning achievement of high school pupils in biology and geometry was affected by scheduling them in classes of one hundred and ten minutes for ninety days instead of fifty-five minutes for one hundred and eighty days, (2) to determine if the retention of learning by high school pupils in biology and geometry was affected by scheduling them in classes of one hundred and ten minutes for ninety days instead of fifty-five minutes for one hundred and eighty days, and (3) to determine the preferences of pupils, so scheduled, for one classtime allocation over the other, and the reasons for their preferences.

The study was conducted in two investigations, A and B. Each investigation included matched experimental and control class groups in biology and geometry. Each was a replication of the other, except for involving different teachers and pupils.

Pupils were pretested to identify entry achievement levels and to establish the pretreatment achievement equivalence of matched classes.

Pupils were posttested to determine cognitive learning achievement in each course. Posttest raw score means of matched biology groups were tested for significance of differences using analysis of covariance. Posttest raw score means and variances of matched geometry groups were tested for significance of differences using analysis of variance and the  $F_{\max}$  test.

Pupils were follow-up tested for retention of achievement eight months following their completion of research classes. Follow-up raw score means of matched biology groups were tested for signifi-



cance of differences using analysis of covariance. Follow-up raw score means and variances of matched geometry groups were tested for significance of differences using analysis of variance and the  $F_{\max}$  test.

## FINDINGS

### Summary of Findings Relative to Pupil Achievement

Analysis of data collected in this study disclosed the following results:

1. The test for significance of difference between adjusted group means in Biology Investigation A produced an F ratio of 3.80 which was significant at the .05 level of confidence. However, a Scheffe test of multiple comparisons disclosed the significant difference was not between an experimental group and the control group. Rather the significant difference was found between the first semester and second semester experimental groups.

The test for significance of difference between adjusted group means in Biology Investigation B resulted in an F ratio of 1.33 which was not significant at the .05 level of confidence.

Scheduling biology classes in periods of one hundred and ten minutes duration for ninety days instead of fifty-five minutes for one hundred and eighty days did not significantly affect the cognitive learning achievement of pupils in these classes.

2. The analysis of variance to test differences between posttest means of classes in Geometry Investigation A yielded a nonsignificant F ratio of .43. The  $F_{\max}$  tests for homogeneity of posttest variances of groups in Geometry Investigation A yielded F ratios of 1.01, 1.46, and 1.48, none of which were significant at the .05 level of confidence.

The analysis of variance to test differences between posttest means of classes in Geometry Investigation B yielded an F ratio of 1.23 which was not significant at the .05 level of confidence. The  $F_{\max}$  tests for homogeneity of posttest variances of groups in Geometry Investigation B yielded F ratios of 1.20, 1.21, and 1.46, none of which were significant at the .05 level of confidence.

Scheduling geometry classes in periods of one hundred and ten minutes duration for ninety days instead of fifty-five minutes for one hundred and eighty days did not significantly affect the cognitive learning achievement of pupils in these classes.

### Summary of Findings Relative to Retention

Analysis of data collected through follow-up testing disclosed the following results:

1. The analysis of covariance testing for significance the adjusted follow-up test group means for biology produced F ratios of .44 and 2.67 for Investigations A and B, respectively. Neither value was significant at the .05 level of confidence.

Scheduling biology classes in periods of one hundred and ten minutes duration for ninety days instead of fifty-five minutes for one hundred and eighty days did not significantly affect the retention of what pupils had learned.

2. The analysis of variance testing for significance the differences between follow-up test group means for geometry produced F ratios of .43 and .09 for Investigations A and B, respectively. Neither value was significant at the .05 level of confidence.

Tests for homogeneity of follow-up test variances resulted in one significant F ratio among six comparisons, that being between Geometry Groups B<sub>1</sub> and B<sub>2</sub>. Since both groups were long-block-of-time experimental groups, and since neither differed significantly in variance from the control group in that investigation, it was concluded that the differences in group variances were due to some factor other than the experimental time variable.

Scheduling geometry classes in periods of one hundred and ten minutes duration for ninety days instead of fifty-five minutes for one hundred and eighty days did not have an effect on the retention of what pupils had learned.

### Summary of Findings Relative to Scheduling Preferences of Pupils

Data collected from pupils who had completed one or two classes in geometry and/or biology in class periods of one hundred and ten minutes for ninety days disclosed the following findings:

1. A comparison of the scheduling preferences of experimental group pupils with a hypothetical population having no difference in scheduling preferences produced a chi square value of 72.72 which was highly significant at the .01 level of confidence. A significant majority of pupils who experienced instruction in the long-block-of-time class period preferred this kind of schedule.

2. Comparisons of the stated scheduling preferences of pupils taking the same courses under different teachers disclosed

significant differences. The chi square value resulting from comparing the scheduling preferences of pupils of Biology Teacher A with those of Biology Teacher B was 13.03. The chi square value resulting from comparing the preferences of pupils of Geometry Teacher A with those of Geometry Teacher B resulted in a value of 11.48. Both values were significant at the .01 level of confidence.

It appears that the teacher does have an effect on whether or not pupils prefer the long-block-of-time class period.

3. A comparison of the scheduling preferences of biology pupils with those of geometry pupils resulted in a non-significant chi square value of .56.

Pupils appear to prefer the long-block-of-time class period to the same extent for both biology classes and geometry classes.

4. The scheduling preferences of several pupils shifted from preference for the long-block-of-time class period to either no preference or to a preference for the traditional class period after they had completed a second course in this kind of schedule. However, when the preferences of first semester pupils were compared to those of second semester pupils, the resulting chi square of 7.52 was not significant at the .01 level of confidence.

Apparently, more pupils change their preference from the long-block-of-time class period than change their preference to this schedule after they become accustomed to it. The extent of this shift in preference is not clear.

5. Pupils who preferred the long-block-of-time class period and those stating no preference preferred it most frequently for reasons connected with learning. Over half of those responding liked the long-block-of-time class period because (a) they thought having fewer subjects divided their attention less and helped them stay more interested, (b) the longer period allowed a greater variety of learning activities, (c) the longer period caused the course to move faster and helped pupils tie the subject into a more meaningful whole, and (d) the more intense concentration on the subject helped them learn it more thoroughly.

Those pupils attached less importance to reasons for preferring the long-block-of-time class period which dealt with personal relationships. Fewer than half of those responding thought the long period improved opportunities for better pupil-teacher relationships. About one pupil in three agreed that having fewer pupils every day helped the teacher get to know and understand them better. A similar proportion of them said the longer period reduced the amount of homework they had outside of class.

No other reason for preferring the long-block-of-time class appeared on as many as ten percent of the opinionnaires.

6. Among pupils who preferred the traditional class schedule and those stating no preference, fifty-nine percent said they lost interest in the subject when they had to concentrate on it too long. The same number stated that covering the subject more rapidly in the long-block-of-time class period kept them from learning it as thoroughly.

Twenty percent, or less, of those pupils stated that taking more subjects made school more interesting, that they got bored sitting in classes of double-period length, and that spending the longer period with a teacher each day caused them to get on each other's nerves.

No other reason was given by as many as ten percent of those respondents for preferring the traditional class schedule.

7. Teachers of long-block-of-time classes reported the following observations relative to adjustments in teaching methods and classroom management under the long-period schedule: (1) long-period classes did not create any problem in holding attention of pupils so long as classroom activities were varied, (2) long-period classes did not adversely affect pupils' motivation to learn, (3) long-period classes were not detrimental to pupils' mastery of subject matter, (4) little or no modification in methods of instruction was found necessary to adapt classes to long class periods, (5) long-period classes did not contribute to problems of pupil misconduct in the classroom, and (6) pupils, generally, responded favorably to long-period classes.

The most serious problem of long-period classes reported by teachers was one of pupils falling behind more quickly when they were absent from school. Getting work made up following absence was more difficult.

Both mathematics teachers and one of the biology teachers concluded that as a result of their experience they preferred the one hundred and ten-minute, ninety-day schedule for their classes. The other biology teacher expressed serious reservations about this kind of class schedule for high school biology classes.

#### CONCLUSIONS

Within the limitations of this study the following generalizations appear to be warranted:

1. High school courses in biology or geometry may be scheduled in class periods of one hundred and ten minutes for one semester rather than in traditional class periods of fifty-five minutes for a full school year without affecting the cognitive learning achievement of pupils enrolled in those classes.

2. High school courses in biology or geometry may be scheduled in class periods of one hundred and ten minutes for one semester rather than in traditional class periods of fifty-five minutes for a full school year without affecting the pupils' retention of what they have learned in those classes.

3. Generally, high school biology and geometry pupils prefer classes taught in double periods for one semester over classes taught in single periods for a full school year.

4. The characteristics of the teacher make a difference in the extent to which pupils prefer the long-block-of-time class period over the traditional class period.

5. Pupils find the long-block-of-time class period equally satisfactory for both biology and geometry classes.

6. Some pupils lose their preference for the long-block-of-time class period after they become more accustomed to it, but most pupils continue to favor it over the traditional class period.

7. Pupils generally prefer the long-block-of-time class period because they feel it improves and enhances their learning opportunities. They do not find that it fosters improved pupil-teacher relationships to a significant degree.

8. Some pupils believe the extended period of daily concentration characteristic of the long-block-of-time class causes them to lose interest in the subject. Others believe they do not master the subject matter as well when they move at an accelerated rate characteristic of the long-block-of-time class period.

#### IMPLICATIONS

The findings of this study have the following implications for the practicing secondary school administrator:

1. Secondary school administrators considering scheduling innovations which would involve extended daily class periods not in excess of two hours may infer from this study that such lengthened periods can be scheduled without the time factor, in itself, being

detrimental to pupil learning or retention. Longer class periods may be adopted for biology and geometry classes, to open up new possibilities for instruction precluded by the traditional single-period class, with the knowledge that the different allocation of class time will not, in itself, be responsible for significant gains or losses in the learning achievement or retention of pupils.

2. Secondary school administrators considering scheduling innovations may infer that extended daily class periods will be acceptable to pupils, especially if classes are planned to include a variety of learning activities each day.

#### RECOMMENDATIONS

This study has made a contribution to the existing body of research available to educators who are considering scheduling innovations in secondary schools. However, the need continues to exist for additional research on the relationship between the allocation of class time and the learning and attitudes of pupils. Specifically, a need exists for well controlled investigations as follows:

1. Similar studies should be conducted with extended period classtime allocations other than the one hundred and ten-minute class period for ninety days.

2. Similar studies should be conducted with other courses in the mathematics and science disciplines, as well as courses in the language arts, social studies, foreign language, fine arts, and practical arts areas.

3. Similar studies should be conducted with different pupil populations including high and low socio-economic groups, slow learners, and secondary school pupils at different levels of maturation.

4. Similar studies should be conducted using different classroom teaching strategies.

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APPENDIX A

DAILY LESSON PLAN FOR PROJECT CLASSES

Date: \_\_\_\_\_ Day of Week: \_\_\_\_\_

Group: \_\_\_\_\_ Teacher: \_\_\_\_\_

LESSON FOR THE DAY:

INSTRUCTIONAL OBJECTIVES FOR THIS LESSON:

INSTRUCTIONAL ACTIVITIES PLANNED:

DEVIATIONS FROM PLANS YOU FOUND NECESSARY:

COMMENTS:

UNIT SUMMARY EVALUATION OF INSTRUCTION IN (CONTROL) CLASSES  
(EXPERIMENTAL)

Group: \_\_\_\_\_ Dates Covered by Unit \_\_\_\_\_ to \_\_\_\_\_

Teacher: \_\_\_\_\_ Title of Unit: \_\_\_\_\_

APPROXIMATE TIME ALLOTTED TO EACH KIND OF INSTRUCTIONAL ACTIVITY  
DURING UNIT:

HOW DID TIME ALLOTTED IN THIS CLASS DIFFER FROM THE TIME ALLOCATION  
IN THE (CONTROL) GROUP?  
(EXPERIMENTAL)

TO WHAT EXTENT DO YOU BELIEVE YOUR UNIT INSTRUCTIONAL OBJECTIVES  
WERE REACHED?

DID THE STUDENTS RESPOND WELL TO THIS UNIT? COMMENT.

WAS INTEREST SUSTAINED THROUGHOUT THE UNIT? Yes No

IF STUDENTS SEEMED TO LOSE INTEREST, AT WHAT POINT IN THE UNIT DID  
INTEREST START TO WANE?

IF YOU WERE TEACHING THIS UNIT AGAIN, WHAT CHANGES WOULD YOU MAKE  
IN ALLOCATION OF TIME OR KINDS OF INSTRUCTIONAL ACTIVITIES?

DAILY EVALUATION OF INSTRUCTION IN (CONTROL)  
(EXPERIMENTAL) CLASSES

Date: \_\_\_\_\_ Day of Week: \_\_\_\_\_

Group: \_\_\_\_\_ Teacher: \_\_\_\_\_

LESSON FOR THE DAY:

APPROXIMATE TIME ALLOTTED TO EACH INSTRUCTIONAL ACTIVITY USED:

HOW DOES THIS DIFFER FROM THE WAY YOUR TIME WAS ALLOTTED IN THE  
(CONTROL) CLASSES?  
(EXPERIMENTAL)

TO WHAT EXTENT DO YOU BELIEVE YOUR INSTRUCTIONAL OBJECTIVES WERE REACHED  
IN TODAY'S LESSON?

DID THE STUDENTS RESPOND FAVORABLY?

Very Well  
About Average  
Not Very Well

COMMENT:

DID THEY SEEM INTERESTED?

DID THEY LOSE INTEREST DURING THE PERIOD? IF SO, AT WHAT POINT?

WERE YOU SATISFIED WITH TODAY'S PROGRESS?

IF YOU WERE TEACHING THIS LESSON AGAIN, WHAT CHANGES WOULD YOU MAKE?



APPENDIX B

Class \_\_\_\_\_

Name \_\_\_\_\_

Section \_\_\_\_\_

STUDENT PREFERENCE OPINIONNAIRE ON ALLOCATION OF CLASS TIME

Administered to Participants in Groups A<sub>1</sub>, A<sub>2</sub>, B<sub>1</sub>, & B<sub>2</sub>

CAPE GIRARDEAU CENTRAL HIGH SCHOOL

PART I: Please check the statement below which best indicates your feelings toward the class you are now taking. Please check only 1 response from 1, 2, or 3.

- \_\_\_\_\_ 1. I prefer taking a class 2 hours a day for 90 days to earn 1 unit of credit instead of taking a class 1 hour a day for 180 days to earn 1 unit of credit.

NOTE: If you check #1 above, go to PART II below and respond to those statements.

- \_\_\_\_\_ 2. I prefer taking a class 1 hour a day for 180 days to earn 1 unit of credit rather than 2 hours a day for 90 days to earn 1 unit of credit.

NOTE: If you check #2 above, skip PART II below and go on to PART III and respond to those statements.

- \_\_\_\_\_ 3. I have no preference between the 2-hour period for 90 days or the 1-hour period for 180 days.

NOTE: If you check #3 above, please proceed to both PARTS II AND III below and check the reasons you like, or dislike, each kind of schedule.

PART II: If you checked #1 or #3 above, please proceed with this section, checking below the REASONS you like the 2-hour schedule for 90 days.

- \_\_\_\_\_ 1. I feel I can stay more interested in the subject when I have fewer subjects at a time to divide my attention.
- \_\_\_\_\_ 2. I feel that more intense concentration on one subject enables me to learn that subject more thoroughly.
- \_\_\_\_\_ 3. Having a longer period of time each day enables the class to participate in a greater variety of learning activities.

- \_\_\_\_\_ 4. A longer period of daily contact between the student and the teacher helps us to get to know and understand each other better.
- \_\_\_\_\_ 5. The teacher knows and understands me better because he/she has fewer students each day to get to know.
- \_\_\_\_\_ 6. I find that in the longer period of time each day the subject moves faster and it helps me tie various fragments of the subject together into a more meaningful whole.
- \_\_\_\_\_ 7. If there are other reasons why you like the 2-hour period for 90 days, please list your reason or reasons in the space below:

PART III: If you checked responses #2 or #3 in PART I of this survey, please proceed with this section, checking below the REASONS you like the 1 hour per day, 180-day schedule.

- \_\_\_\_\_ 1. I lose interest in the subject when I have to concentrate too long on it.
- \_\_\_\_\_ 2. I feel we cover the subject matter so rapidly in the 2-hour/90-day class that I do not have a chance to learn the subject as thoroughly as I do in the regular 1-hour/180-day class.
- \_\_\_\_\_ 3. I find that when I spend a longer period of time with the same teacher each day, we get on each other's nerves.
- \_\_\_\_\_ 4. Taking more subjects at one time makes school more interesting.
- \_\_\_\_\_ 5. If there are other reasons why you prefer the 1-hour/180-day class schedule, please list your reason, or reasons, in the space below:

APPENDIX C

APPENDIX C-1

PRE-TREATMENT CHARACTERISTICS OF SUBJECTS BY MATCHED GROUPS  
BIOLOGY INVESTIGATION A

| Group A <sub>1</sub> |             |       |       | Group A <sub>g</sub> |        |       |       | Group A <sub>2</sub> |             |       |       |
|----------------------|-------------|-------|-------|----------------------|--------|-------|-------|----------------------|-------------|-------|-------|
| Student No.          | Grade       | C.A.  | M.A.  | Student No.          | Grade  | C.A.  | M.A.  | Student No.          | Grade       | C.A.  | M.A.  |
| 73192                | 10          | 181   | 219.0 | 73005                | 10     | 184   | 219.9 | 73265                | 10          | 181   | 219.0 |
| 73268                | 10          | 183   | 188.5 | 73027                | 10     | 180   | 187.2 | 73379                | 10          | 180   | 183.6 |
| 73109                | 10          | 180   | 223.2 | 73043                | 10     | 179   | 221.1 | 73347                | Transferred |       |       |
| 73260                | Transferred |       |       | 73060                | 10     | 185   | 194.3 | 73177                | 10          | 185   | 198.0 |
| 73335                | 10          | 179   | 207.6 | 73069                | 10     | 177   | 209.7 | 73449                | Transferred |       |       |
| 74149                | 9           | 178   | 210.0 | 74095                | 9      | 174   | 214.9 | 74033                | 9           | 179   | 211.2 |
| 73093                | 10          | 181   | 215.4 | 74127                | 9      | 179   | 219.3 | 73099                | 10          | 185   | 214.6 |
| 73071                | 10          | 183   | 214.1 | 73127                | 10     | 182   | 214.8 | 73067                | 10          | 184   | 213.4 |
| 73360                | 10          | 185   | 194.3 | 73168                | 10     | 186   | 194.4 | 73107                | 10          | 185   | 194.3 |
| 74218                | 9           | 178   | 218.9 | 74184                | 9      | 179   | 215.7 | 74413                | 9           | 174   | 217.5 |
| 73209                | 10          | 183   | 223.3 | 73214                | 10     | 183   | 222.3 | 73121                | Transferred |       |       |
| 74209                | 9           | 171   | 193.2 | 74200                | 9      | 168   | 196.6 | 74433                | 9           | 171   | 196.7 |
| 73066                | 10          | 180   | 208.8 | 73229                | 10     | 178   | 207.4 | 73343                | 10          | 180   | 207.0 |
| 74016                | 9           | 176   | 220.0 | 74222                | 9      | 175   | 219.6 | 74137                | Transferred |       |       |
| 74012                | 9           | 177   | 210.6 | 74237                | 9      | 177   | 210.6 | 74116                | 9           | 178   | 210.0 |
| 74316                | 9           | 176   | 246.6 | 74243                | 9      | 177   | 250.5 | 74355                | 9           | 178   | 252.8 |
| 73011                | Transferred |       |       | 73273                | 10     | 191   | 218.7 | 73148                | 10          | 186   | 219.5 |
| 74139                | 9           | 170   | 214.2 | 74286                | 9      | 169   | 215.5 | 74208                | Transferred |       |       |
| 74262                | 9           | 176   | 216.5 | 74298                | 9      | 173   | 214.5 | 74336                | 9           | 171   | 213.8 |
| 73468                | 10          | 184   | 217.1 | 73397                | 10     | 187   | 217.9 | 73178                | 10          | 185   | 212.9 |
| 73378                | 10          | 182   | 211.1 | 73399                | 10     | 180   | 212.4 | 73119                | 10          | 177   | 214.2 |
| 73110                | 10          | 189   | 228.7 | 73403                | 10     | 190   | 224.2 | 73199                | 10          | 189   | 224.9 |
| 73065                | 10          | 181   | 200.9 | 73411                | 10     | 180   | 199.8 | 73448                | 10          | 181   | 200.9 |
| 73404                | 10          | 181   | 228.1 | 73347                | 10     | 182   | 223.9 | 73450                | 10          | 179   | 224.6 |
| Means                | 9.6         | 179.7 | 214.1 | Means                | 9.6    | 179.8 | 213.6 | Means                | 9.7         | 180.4 | 212.0 |
| Group A <sub>1</sub> | N = 22      |       |       | Group A <sub>g</sub> | N = 24 |       |       | Group A <sub>2</sub> | N = 19      |       |       |

# APPENDIX C-2

## PRE-TREATMENT CHARACTERISTICS OF SUBJECTS BY MATCHED GROUPS

### BIOLOGY INVESTIGATION B

| Group B <sub>1</sub> |             |       |       | Group B <sub>9</sub> |             |       |       | Group B <sub>2</sub> |             |       |       |
|----------------------|-------------|-------|-------|----------------------|-------------|-------|-------|----------------------|-------------|-------|-------|
| Student No.          | Grade       | C.A.  | M.A.  | Student No.          | Grade       | C.A.  | M.A.  | Student No.          | Grade       | C.A.  | M.A.  |
| 74443                | 9           | 169   | 202.8 | 74014                | 9           | 173   | 204.1 | 74145                | 9           | 169   | 204.5 |
| 74384                | 9           | 171   | 210.3 | 74023                | 9           | 176   | 208.3 | 74118                | 9           | 175   | 208.3 |
| 74399                | 9           | 174   | 243.6 | 74093                | 9           | 171   | 232.6 | 74257                | 9           | 179   | 241.9 |
| 74319                | 9           | 166   | 219.1 | 74115                | 9           | 179   | 219.3 | 74249                | 9           | 168   | 220.1 |
| 73138                | 10          | 191   | 194.8 | 73132                | Transferred |       |       | 73305                | 10          | 181   | 194.7 |
| 74264                | 9           | 173   | 235.5 | 73146                | 10          | 174   | 203.6 | 74132                | Transferred |       |       |
| 74027                | Transferred |       |       | 74169                | 9           | 177   | 222.1 | 74189                | 9           | 172   | 220.6 |
| 74392                | 9           | 175   | 231.0 | 74223                | 9           | 174   | 232.2 | 74430                | 9           | 179   | 229.1 |
| 73412                | 10          | 186   | 186.0 | 73251                | 10          | 184   | 188.6 | 74282                | 9           | 174   | 188.8 |
| 74136                | 9           | 177   | 200.0 | 74239                | 9           | 177   | 199.1 | 74407                | 9           | 177   | 194.7 |
| 74081                | 9           | 170   | 224.4 | 74248                | 9           | 171   | 225.7 | 74244                | 9           | 175   | 229.2 |
| 74330                | 9           | 188   | 229.3 | 74255                | 9           | 176   | 226.2 | 73377                | 10          | 189   | 230.6 |
| 73308                | 10          | 186   | 230.5 | 73299                | 10          | 182   | 229.3 | 73196                | 10          | 183   | 234.2 |
| 74044                | 9           | 177   | 230.1 | 74280                | 9           | 179   | 228.2 | 74025                | 9           | 161   | 233.5 |
| 73056                | 10          | 189   | 204.1 | 72315                | Transferred |       |       | 73050                | 10          | 186   | 208.3 |
| 73224                | 10          | 186   | 208.3 | 74325                | 9           | 170   | 209.1 | 73204                | 10          | 185   | 210.9 |
| 73359                | 10          | 183   | 208.6 | 74348                | 9           | 177   | 206.2 | 73460                | 10          | 182   | 209.3 |
| 74021                | 9           | 173   | 218.0 | 74362                | 9           | 175   | 217.0 | 74420                | 9           | 174   | 215.2 |
| 74180                | 9           | 168   | 213.4 | 74387                | 9           | 170   | 212.5 | 74381                | 9           | 165   | 213.2 |
| 74064                | 9           | 168   | 205.0 | 74411                | 9           | 169   | 204.5 | 74326                | 9           | 174   | 203.5 |
| 73365                | 10          | 182   | 238.4 | 73441                | 10          | 187   | 219.7 | 73400                | 10          | 186   | 241.8 |
| 74141                | 9           | 169   | 198.7 | 74436                | 9           | 169   | 203.6 | 74178                | 9           | 173   | 199.0 |
| 74303                | 9           | 177   | 224.8 | 74438                | 9           | 179   | 223.7 | 74029                | 9           | 179   | 220.2 |
| 73063                | 10          | 180   | 194.8 | 73467                | 10          | 183   | 196.0 | 73188                | 10          | 182   | 200.7 |
| Means                | 9.3         | 177.3 | 215.3 | Means                | 9.2         | 176.0 | 214.2 | Means                | 9.3         | 176.9 | 215.5 |
| Group B <sub>1</sub> | N = 23      |       |       | Group B <sub>9</sub> | N = 22      |       |       | Group B <sub>2</sub> | N = 23      |       |       |

# APPENDIX C-3

## PRE-TREATMENT CHARACTERISTICS OF SUBJECTS BY MATCHED GROUPS GEOMETRY INVESTIGATION A

| Group A <sub>1</sub> |             |       |       |  | Group A <sub>10</sub> |        |       |       |  | Group A <sub>2</sub> |             |       |       |  |
|----------------------|-------------|-------|-------|--|-----------------------|--------|-------|-------|--|----------------------|-------------|-------|-------|--|
| Student No.          | Grade       | C.A.  | M.A.  |  | Student No.           | Grade  | C.A.  | M.A.  |  | Student No.          | Grade       | C.A.  | M.A.  |  |
| 73209                | 10          | 183   | 223.3 |  | 73015                 | 10     | 183   | 225.1 |  | 73121                | 10          | 184   | 224.5 |  |
| 73192                | 10          | 181   | 219.0 |  | 73031                 | 10     | 181   | 219.9 |  | 73265                | 10          | 181   | 219.0 |  |
| 73071                | 10          | 183   | 314.1 |  | 73044                 | 10     | 187   | 212.2 |  | 73067                | 10          | 184   | 213.4 |  |
| 73065                | 10          | 181   | 200.9 |  | 73059                 | 10     | 179   | 202.3 |  | 73448                | 10          | 181   | 200.9 |  |
| 74149                | 9           | 178   | 210.0 |  | 74102                 | 9      | 179   | 212.1 |  | 74033                | 9           | 179   | 211.2 |  |
| 74139                | 9           | 170   | 214.2 |  | 74130                 | 9      | 168   | 216.7 |  | 74208                | 9           | 168   | 218.4 |  |
| 73011                | Transferred |       |       |  | 73151                 | 10     | 188   | 219.0 |  | 73148                | 10          | 186   | 219.5 |  |
| 73335                | 10          | 179   | 207.6 |  | 73155                 | 10     | 181   | 208.2 |  | 73449                | Transferred |       |       |  |
| 73404                | 10          | 181   | 228.1 |  | 73161                 | 10     | 180   | 223.2 |  | 73450                | 10          | 179   | 224.6 |  |
| 73360                | 10          | 185   | 194.3 |  | 73181                 | 10     | 181   | 196.4 |  | 73107                | 10          | 185   | 194.3 |  |
| 74262                | 9           | 176   | 216.5 |  | 74173                 | 9      | 173   | 213.7 |  | 74336                | 9           | 171   | 213.8 |  |
| 74316                | 9           | 176   | 246.6 |  | 74175                 | 9      | 179   | 251.5 |  | 74355                | 9           | 178   | 252.8 |  |
| 73260                | Transferred |       |       |  | 73200                 | 10     | 187   | 197.3 |  | 73177                | 10          | 185   | 198.0 |  |
| 74218                | 9           | 178   | 218.9 |  | 74207                 | 9      | 174   | 217.5 |  | 74413                | 9           | 174   | 217.5 |  |
| 73109                | 10          | 180   | 223.2 |  | 73233                 | 10     | 177   | 222.1 |  | 73347                | Transferred |       |       |  |
| 74209                | 9           | 171   | 193.2 |  | 74214                 | 9      | 168   | 195.7 |  | 74433                | 9           | 171   | 196.7 |  |
| 73268                | Transferred |       |       |  | 73264                 | 10     | 182   | 185.6 |  | 73379                | 10          | 180   | 183.6 |  |
| 73468                | 10          | 184   | 217.1 |  | 73286                 | 10     | 188   | 214.3 |  | 73178                | 10          | 185   | 212.9 |  |
| 73093                | 10          | 181   | 215.4 |  | 73307                 | 10     | 184   | 215.3 |  | 73099                | 10          | 185   | 214.6 |  |
| 73066                | 10          | 180   | 208.8 |  | 73339                 | 10     | 181   | 206.3 |  | 73343                | 10          | 180   | 207.0 |  |
| 73378                | 10          | 182   | 211.1 |  | 73346                 | 10     | 185   | 215.5 |  | 73119                | 10          | 177   | 214.2 |  |
| 73110                | 10          | 189   | 228.7 |  | 73375                 | 10     | 188   | 224.7 |  | 73199                | 10          | 189   | 224.9 |  |
| 74012                | 9           | 177   | 210.6 |  | 73472                 | 9      | 179   | 208.5 |  | 74116                | 9           | 178   | 210.0 |  |
| 74016                | 9           | 176   | 220.0 |  | 73426                 | 9      | 183   | 215.0 |  | 74137                | Transferred |       |       |  |
| Means                | 9.6         | 179.6 | 215.3 |  | Means                 | 9.7    | 180.6 | 213.3 |  | Means                | 9.7         | 180.0 | 212.9 |  |
| Group A <sub>1</sub> | N = 21      |       |       |  | Group A <sub>10</sub> | N = 24 |       |       |  | Group A <sub>2</sub> | N = 21      |       |       |  |

# APPENDIX C-4

## PRE-TREATMENT CHARACTERISTICS OF SUBJECTS BY MATCHED GROUPS GEOMETRY INVESTIGATION B

| Group B <sub>1</sub> |             |       |       | Group B <sub>10</sub> |             |       |       | Group B <sub>2</sub> |             |       |       |
|----------------------|-------------|-------|-------|-----------------------|-------------|-------|-------|----------------------|-------------|-------|-------|
| Student No.          | Grade       | C.A.  | M.A.  | Student No.           | Grade       | C.A.  | M.A.  | Student No.          | Grade       | C.A.  | M.A.  |
| 73056                | 10          | 189   | 204.1 | 73024                 | 10          | 188   | 204.9 | 73050                | 10          | 186   | 208.3 |
| 74264                | 9           | 173   | 235.5 | 74075                 | Transferred |       |       | 74257                | 9           | 179   | 241.9 |
| 73138                | 10          | 191   | 194.8 | 73512                 | Transferred |       |       | 74132                | Transferred |       |       |
| 73063                | 10          | 180   | 194.8 | 73083                 | 10          | 185   | 198.2 | 73188                | 10          | 182   | 200.7 |
| 73308                | 10          | 186   | 230.6 | 73126                 | 10          | 185   | 229.4 | 73196                | 10          | 183   | 234.2 |
| 74443                | 9           | 169   | 202.8 | 74140                 | 9           | 171   | 203.4 | 74145                | 9           | 169   | 204.5 |
| 74064                | 9           | 168   | 205.0 | 73150                 | 10          | 188   | 209.6 | 74326                | 9           | 174   | 203.5 |
| 74136                | Transferred |       |       | 73175                 | 10          | 182   | 199.3 | 74407                | 9           | 177   | 194.7 |
| 74180                | 9           | 168   | 213.4 | 73206                 | 10          | 187   | 213.2 | 74381                | 9           | 165   | 213.2 |
| 74399                | 9           | 174   | 243.6 | 73511                 | 10          | 178   | 199.4 | 73305                | 10          | 181   | 194.7 |
| 73365                | 10          | 182   | 238.4 | 73241                 | 10          | 185   | 241.4 | 73400                | 10          | 186   | 241.8 |
| 74330                | 9           | 188   | 229.3 | 73250                 | 9           | 189   | 231.5 | 73377                | 10          | 189   | 230.6 |
| 74392                | 9           | 175   | 231.0 | 74246                 | 9           | 177   | 233.6 | 74430                | 9           | 179   | 229.1 |
| 74141                | 9           | 169   | 198.7 | 74252                 | 9           | 169   | 201.1 | 74178                | 9           | 173   | 199.0 |
| 74303                | 9           | 177   | 224.8 | 74301                 | 9           | 178   | 224.3 | 74029                | 9           | 179   | 220.2 |
| 73412                | 10          | 186   | 186.0 | 73336                 | Transferred |       |       | 74284                | 9           | 174   | 188.8 |
| 74044                | 9           | 177   | 230.1 | 74340                 | 9           | 174   | 229.7 | 74244                | 9           | 175   | 229.2 |
| 74081                | 9           | 170   | 224.4 | 73369                 | 10          | 180   | 227.7 | 74420                | 9           | 174   | 219.2 |
| 74384                | 9           | 171   | 210.3 | 74346                 | 9           | 179   | 208.5 | 74118                | 9           | 175   | 208.3 |
| 74027                | Transferred |       |       | 74360                 | 9           | 180   | 217.8 | 74189                | 9           | 172   | 220.6 |
| 74319                | 9           | 166   | 219.1 | 74361                 | 9           | 180   | 217.8 | 74249                | 9           | 168   | 220.1 |
| 74021                | 9           | 173   | 218.0 | 73423                 | 10          | 180   | 230.4 | 74025                | 9           | 161   | 233.5 |
| 73224                | 10          | 186   | 208.3 | 73424                 | 10          | 190   | 210.1 | 73204                | 10          | 185   | 210.9 |
| 73359                | 10          | 183   | 208.6 | 73461                 | 10          | 186   | 204.6 | 73460                | 10          | 182   | 209.3 |
| Means                | 9.4         | 177.3 | 216.0 | Means                 | 9.6         | 181.5 | 216.0 | Means                | 9.3         | 176.9 | 215.5 |
| Group B <sub>1</sub> |             |       |       | Group B <sub>10</sub> |             |       |       | Group B <sub>2</sub> |             |       |       |
| N = 22               |             |       |       | N = 21                |             |       |       | N = 23               |             |       |       |



APPENDIX D

APPENDIX D-1  
BSCS GREEN VERSION HIGH SCHOOL BIOLOGY COMPREHENSIVE FINAL EXAMINATION  
PRETEST AND POSTTEST RAW SCORES OF SUBJECTS BY GROUPS  
BIOLOGY INVESTIGATION A

| Group A <sub>1</sub><br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Group A <sub>2</sub><br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Group A <sub>2</sub><br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss |
|-------------------------------------|-----------------------|------------------------|--------------------|-------------------------------------|-----------------------|------------------------|--------------------|-------------------------------------|-----------------------|------------------------|--------------------|
|                                     | Score                 | Score                  | Loss               |                                     | Score                 | Score                  | Loss               |                                     | Score                 | Score                  | Loss               |
| 73192                               | 25                    | 24                     | -1                 | 73005                               | 19                    | 30                     | 11                 | 73265                               | 16                    | 21                     | 5                  |
| 73268                               | 11                    | 14                     | 3                  | 73027                               | 8                     | 16                     | 8                  | 73379                               | 12                    | 17                     | 5                  |
| 73109                               | 6                     | 14                     | 8                  | 73043                               | 15                    | 25                     | 10                 | 73347                               | Transferred           |                        |                    |
| 73260                               | Transferred           |                        |                    | 73060                               | 13                    | 25                     | 12                 | 73177                               | 14                    | 14                     | 0                  |
| 73335                               | 16                    | 15                     | -1                 | 73069                               | 19                    | 19                     | 0                  | 73449                               | Transferred           |                        |                    |
| 74149                               | 24                    | 29                     | 5                  | 74095                               | 22                    | 31                     | 9                  | 74033                               | 22                    | 33                     | 11                 |
| 73071                               | 20                    | 20                     | 0                  | 73127                               | 18                    | 18                     | 0                  | 73067                               | 13                    | 19                     | 6                  |
| 73093                               | 11                    | 24                     | 13                 | 74127                               | 25                    | 33                     | 8                  | 73099                               | 15                    | 20                     | 5                  |
| 73360                               | 14                    | 15                     | 1                  | 73168                               | 16                    | 18                     | 2                  | 73107                               | 17                    | 23                     | 6                  |
| 74218                               | 18                    | 27                     | 9                  | 74184                               | 10                    | 21                     | 11                 | 74413                               | 21                    | 33                     | 12                 |
| 73209                               | 18                    | 22                     | 4                  | 73214                               | 13                    | 16                     | 3                  | 73121                               | Transferred           |                        |                    |
| 74209                               | 20                    | 34                     | 14                 | 74200                               | 24                    | 34                     | 10                 | 74433                               | 16                    | 22                     | 6                  |
| 73066                               | 9                     | 14                     | 5                  | 73229                               | 17                    | 19                     | 2                  | 73343                               | 14                    | 27                     | 13                 |
| 74016                               | 21                    | 22                     | 1                  | 74222                               | 13                    | 21                     | 8                  | 74137                               | Transferred           |                        |                    |
| 74012                               | 23                    | 31                     | 8                  | 74237                               | 14                    | 27                     | 13                 | 74116                               | 23                    | 37                     | 14                 |
| 74316                               | 26                    | 34                     | 8                  | 74243                               | 21                    | 36                     | 15                 | 74355                               | 15                    | 28                     | 13                 |
| 73011                               | Transferred           |                        |                    | 73273                               | 17                    | 16                     | -1                 | 73148                               | 9                     | 21                     | 12                 |
| 74139                               | 15                    | 23                     | 8                  | 74286                               | 19                    | 28                     | 9                  | 74208                               | Transferred           |                        |                    |
| 74262                               | 22                    | 25                     | 3                  | 74298                               | 19                    | 24                     | 5                  | 74336                               | 22                    | 31                     | 9                  |
| 73404                               | 19                    | 21                     | 2                  | 73347                               | 15                    | 17                     | 2                  | 73450                               | 14                    | 35                     | 21                 |
| 73468                               | 17                    | 20                     | 3                  | 73397                               | 15                    | 20                     | 5                  | 73178                               | 12                    | 27                     | 15                 |
| 73378                               | 16                    | 18                     | 2                  | 73399                               | 18                    | 20                     | 2                  | 73119                               | 20                    | 22                     | 2                  |
| 73110                               | 19                    | 21                     | 2                  | 73403                               | 11                    | 19                     | 8                  | 73199                               | 21                    | 27                     | 6                  |
| 73065                               | 16                    | 22                     | 6                  | 73411                               | 10                    | 23                     | 13                 | 73448                               | 18                    | 25                     | 7                  |
| Sums                                | 386                   | 489                    | 103                | Sums                                | 391                   | 556                    | 165                | Sums                                | 314                   | 482                    | 168                |
| Means                               | 17.55                 | 22.23                  | 4.68               | Means                               | 16.29                 | 23.17                  | 6.88               | Means                               | 16.53                 | 25.37                  | 8.84               |
| Std. Dev.                           | 5.19                  | 6.08                   |                    | Std. Dev.                           | 4.40                  | 6.11                   |                    | Std. Dev.                           | 4.02                  | 6.35                   |                    |
| Pre/Post                            | r = .737              |                        |                    | Pre/Post                            | r = .643              |                        |                    | Pre/Post                            | r = .588              |                        |                    |
| N = 22                              |                       |                        |                    | N = 24                              |                       |                        |                    | N = 19                              |                       |                        |                    |

APPENDIX D-2  
BSCS GREEN VERSION HIGH SCHOOL BIOLOGY COMPREHENSIVE FINAL EXAMINATION  
PRETEST AND POSTTEST RAW SCORES OF SUBJECTS BY GROUPS  
BIOLOGY INVESTIGATION B

| Group B <sub>1</sub><br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Group B <sub>9</sub><br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Group B <sub>2</sub><br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss |
|-------------------------------------|-----------------------|------------------------|--------------------|-------------------------------------|-----------------------|------------------------|--------------------|-------------------------------------|-----------------------|------------------------|--------------------|
| 74443                               | 15                    | 27                     | 12                 | 74014                               | 16                    | 28                     | 12                 | 74145                               | 20                    | 32                     | 12                 |
| 74384                               | 23                    | 30                     | 7                  | 74023                               | 12                    | 20                     | 8                  | 74118                               | 22                    | 30                     | 8                  |
| 74399                               | 22                    | 30                     | 8                  | 74093                               | 22                    | 37                     | 15                 | 74257                               | 30                    | 33                     | 3                  |
| 74319                               | 17                    | 19                     | 2                  | 74115                               | 22                    | 28                     | 6                  | 74249                               | 18                    | 19                     | 1                  |
| 73138                               | 12                    | 16                     | 4                  | 73132                               | Transferred           |                        |                    | 73305                               | 12                    | 17                     | 5                  |
| 74264                               | 16                    | 31                     | 15                 | 73146                               | 10                    | 16                     | 6                  | 74132                               | Transferred           |                        |                    |
| 74027                               | Transferred           |                        |                    | 74169                               | 14                    | 22                     | 8                  | 74189                               | 21                    | 39                     | 18                 |
| 74392                               | 27                    | 31                     | 4                  | 74223                               | 22                    | 32                     | 10                 | 74430                               | 18                    | 19                     | 1                  |
| 73412                               | 14                    | 13                     | -1                 | 73251                               | 14                    | 17                     | 3                  | 74284                               | 17                    | 19                     | 2                  |
| 74136                               | 17                    | 17                     | 0                  | 74239                               | 24                    | 24                     | 0                  | 74407                               | 25                    | 26                     | 1                  |
| 74081                               | 23                    | 38                     | 15                 | 74248                               | 14                    | 27                     | 13                 | 74244                               | 21                    | 26                     | 5                  |
| 74330                               | 21                    | 32                     | 11                 | 74255                               | 19                    | 32                     | 13                 | 73377                               | 26                    | 22                     | -4                 |
| 73308                               | 15                    | 20                     | 5                  | 73299                               | 24                    | 26                     | 2                  | 73196                               | 15                    | 22                     | 7                  |
| 74044                               | 21                    | 27                     | 6                  | 74280                               | 15                    | 19                     | 4                  | 74025                               | 17                    | 19                     | 2                  |
| 73056                               | 18                    | 24                     | 6                  | 72315                               | Transferred           |                        |                    | 73050                               | 16                    | 17                     | 1                  |
| 73224                               | 17                    | 24                     | 7                  | 74325                               | 13                    | 20                     | 7                  | 73204                               | 11                    | 16                     | 5                  |
| 73359                               | 15                    | 22                     | 7                  | 74348                               | 12                    | 20                     | 8                  | 73460                               | 17                    | 21                     | 4                  |
| 74021                               | 17                    | 23                     | 6                  | 74362                               | 13                    | 22                     | 9                  | 74420                               | 25                    | 26                     | 1                  |
| 74180                               | 31                    | 35                     | 4                  | 74387                               | 20                    | 27                     | 7                  | 74381                               | 22                    | 28                     | 6                  |
| 74064                               | 17                    | 23                     | 6                  | 74411                               | 16                    | 27                     | 11                 | 74326                               | 19                    | 29                     | 10                 |
| 73365                               | 21                    | 22                     | 1                  | 73441                               | 11                    | 15                     | 4                  | 73400                               | 27                    | 34                     | 7                  |
| 74141                               | 23                    | 25                     | 2                  | 74436                               | 17                    | 22                     | 5                  | 74178                               | 21                    | 24                     | 3                  |
| 74303                               | 15                    | 22                     | 7                  | 74438                               | 17                    | 24                     | 7                  | 74029                               | 15                    | 25                     | 10                 |
| 73063                               | 23                    | 26                     | 3                  | 73467                               | 13                    | 19                     | 6                  | 73188                               | 11                    | 19                     | 8                  |
| Sums                                | 440                   | 577                    | 137                | Sums                                | 360                   | 524                    | 164                | Sums                                | 446                   | 562                    | 116                |
| Means                               | 19.13                 | 25.09                  | 5.96               | Means                               | 16.36                 | 23.82                  | 7.46               | Means                               | 19.39                 | 24.43                  | 5.04               |
| Std. Dev.                           | 4.58                  | 6.16                   |                    | Std. Dev.                           | 4.33                  | 5.62                   |                    | Std. Dev.                           | 5.07                  | 6.25                   |                    |
| Pre/Post r = .726                   |                       |                        |                    | Pre/Post r = .737                   |                       |                        |                    | Pre/Post r = .675                   |                       |                        |                    |
| N = 23                              |                       |                        |                    | N = 22                              |                       |                        |                    | N = 23                              |                       |                        |                    |

APPENDIX E

APPENDIX E-1  
HOWELL GEOMETRY TEST PRETEST AND POSTTEST RAW SCORES OF SUBJECTS BY GROUPS  
GEOMETRY INVESTIGATION A

| Group A <sub>1</sub> |                       |                        |                    | Group A <sub>10</sub> |                       |                        |                    | Group A <sub>2</sub> |                       |                        |                    |
|----------------------|-----------------------|------------------------|--------------------|-----------------------|-----------------------|------------------------|--------------------|----------------------|-----------------------|------------------------|--------------------|
| Student No.          | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Student No.           | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Student No.          | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss |
| 73209                | 10                    | 34                     | 24                 | 73015                 | 14                    | 24                     | 10                 | 73121                | 2                     | 19                     | 17                 |
| 73192                | 11                    | 29                     | 18                 | 73031                 | 5                     | 19                     | 14                 | 73265                | 16                    | 32                     | 16                 |
| 73071                | 14                    | 15                     | 1                  | 73044                 | 12                    | 31                     | 19                 | 73067                | 6                     | 20                     | 14                 |
| 73065                | 15                    | 13                     | - 2                | 73059                 | 4                     | 26                     | 22                 | 73448                | 12                    | 23                     | 11                 |
| 74149                | 14                    | 27                     | 13                 | 74102                 | 11                    | 20                     | 9                  | 74033                | 6                     | 30                     | 24                 |
| 74139                | 8                     | 25                     | 17                 | 74130                 | 12                    | 27                     | 15                 | 74208                | 8                     | 27                     | 19                 |
| 73011                | Transferred           |                        |                    | 73151                 | 0                     | 24                     | 24                 | 73148                | 13                    | 22                     | 9                  |
| 73335                | 9                     | 33                     | 24                 | 73155                 | 16                    | 24                     | 8                  | 73449                | Transferred           |                        |                    |
| 73404                | 14                    | 25                     | 11                 | 73161                 | 14                    | 18                     | 4                  | 73450                | 4                     | 36                     | 32                 |
| 73360                | 9                     | 17                     | 8                  | 73181                 | 6                     | 19                     | 13                 | 73107                | 4                     | 20                     | 16                 |
| 74262                | 7                     | 30                     | 23                 | 74173                 | 13                    | 30                     | 17                 | 74336                | 21                    | 27                     | 6                  |
| 74316                | 13                    | 31                     | 18                 | 74175                 | 7                     | 35                     | 28                 | 74355                | 17                    | 32                     | 15                 |
| 73260                | Transferred           |                        |                    | 73200                 | 1                     | 14                     | 13                 | 73177                | 10                    | 21                     | 11                 |
| 74218                | 8                     | 24                     | 16                 | 74207                 | 6                     | 32                     | 26                 | 74413                | 12                    | 28                     | 16                 |
| 73109                | 11                    | 19                     | 8                  | 73233                 | 17                    | 26                     | 9                  | 73347                | Transferred           |                        |                    |
| 74209                | 19                    | 33                     | 14                 | 74214                 | 8                     | 26                     | 18                 | 74433                | 8                     | 26                     | 18                 |
| 73268                | Transferred           |                        |                    | 73264                 | 12                    | 21                     | 9                  | 73379                | 10                    | 14                     | 4                  |
| 73468                | 16                    | 29                     | 13                 | 73286                 | 19                    | 23                     | 4                  | 73178                | 19                    | 26                     | 7                  |
| 73093                | 6                     | 30                     | 24                 | 73307                 | 13                    | 22                     | 9                  | 73099                | 10                    | 18                     | 8                  |
| 73066                | 12                    | 23                     | 11                 | 73339                 | 8                     | 19                     | 11                 | 73343                | 11                    | 20                     | 9                  |
| 73378                | 13                    | 21                     | 8                  | 73346                 | 9                     | 26                     | 17                 | 73119                | 11                    | 22                     | 11                 |
| 73110                | 17                    | 39                     | 22                 | 73375                 | 10                    | 35                     | 25                 | 73199                | 11                    | 28                     | 17                 |
| 74012                | 11                    | 29                     | 18                 | 74372                 | 10                    | 30                     | 20                 | 74116                | 13                    | 28                     | 15                 |
| 74016                | 11                    | 25                     | 14                 | 73426                 | 14                    | 27                     | 13                 | 74137                | Transferred           |                        |                    |
| Sums                 | 248                   | 551                    | 303                | Sums                  | 241                   | 598                    | 357                | Sums                 | 224                   | 519                    | 295                |
| Means                | 11.81                 | 26.24                  | 14.43              | Means                 | 10.04                 | 24.92                  | 14.88              | Means                | 10.67                 | 24.71                  | 14.04              |
| Std. Dev.            | 3.40                  | 6.62                   |                    | Std. Dev.             | 4.83                  | 5.44                   |                    | Std. Dev.            | 4.91                  | 5.47                   |                    |
| Pre/Post             | r = .058              |                        |                    | Pre/Post              | r = .126              |                        |                    | Pre/Post             | r = .240              |                        |                    |
| N = 21               |                       |                        |                    | N = 24                |                       |                        |                    | N = 21               |                       |                        |                    |

APPENDIX E-2  
HOWELL GEOMETRY TEST PRETEST AND POSTTEST RAW SCORES OF SUBJECTS BY GROUPS  
GEOMETRY INVESTIGATION B

| Group B1<br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Group B10<br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss | Group B2<br>Student No. | Pre-<br>test<br>Score | Post-<br>test<br>Score | Gain<br>or<br>Loss |
|-------------------------|-----------------------|------------------------|--------------------|--------------------------|-----------------------|------------------------|--------------------|-------------------------|-----------------------|------------------------|--------------------|
| 73056                   | 7                     | 21                     | 14                 | 73024                    | 9                     | 14                     | 5                  | 73050                   | 9                     | 14                     | 5                  |
| 74264                   | 10                    | 25                     | 15                 | 74075                    | Transferred           |                        |                    | 74257                   | 13                    | 25                     | 12                 |
| 73138                   | 8                     | 18                     | 10                 | 73512                    | Transferred           |                        |                    | 74132                   | Transferred           |                        |                    |
| 73063                   | 10                    | 23                     | 13                 | 73083                    | 6                     | 19                     | 13                 | 73188                   | 10                    | 16                     | 6                  |
| 73308                   | 12                    | 13                     | 1                  | 73126                    | 12                    | 23                     | 11                 | 73196                   | 6                     | 16                     | 10                 |
| 74443                   | 10                    | 26                     | 16                 | 74140                    | 6                     | 32                     | 26                 | 74145                   | 12                    | 24                     | 12                 |
| 74064                   | 8                     | 22                     | 14                 | 73150                    | 7                     | 21                     | 14                 | 74326                   | 12                    | 30                     | 18                 |
| 74136                   | Transferred           |                        |                    | 73175                    | 12                    | 27                     | 15                 | 74407                   | 15                    | 19                     | 4                  |
| 74180                   | 21                    | 33                     | 12                 | 73206                    | 11                    | 14                     | 3                  | 74381                   | 13                    | 27                     | 14                 |
| 74399                   | 12                    | 23                     | 11                 | 73511                    | 7                     | 18                     | 11                 | 73305                   | 11                    | 14                     | 3                  |
| 73365                   | 19                    | 26                     | 7                  | 73241                    | 16                    | 26                     | 10                 | 73400                   | 15                    | 26                     | 11                 |
| 74330                   | 6                     | 24                     | 18                 | 73250                    | 13                    | 25                     | 12                 | 73377                   | 13                    | 19                     | 6                  |
| 74392                   | 8                     | 29                     | 21                 | 74246                    | 12                    | 27                     | 15                 | 74430                   | 9                     | 20                     | 11                 |
| 74141                   | 7                     | 25                     | 18                 | 74252                    | 7                     | 29                     | 22                 | 74178                   | 10                    | 29                     | 19                 |
| 74303                   | 7                     | 14                     | 7                  | 74301                    | 12                    | 22                     | 10                 | 74029                   | 4                     | 27                     | 23                 |
| 73412                   | 8                     | 19                     | 11                 | 73336                    | Transferred           |                        |                    | 74284                   | 18                    | 22                     | 4                  |
| 74044                   | 9                     | 18                     | 9                  | 74340                    | 10                    | 23                     | 13                 | 74244                   | 13                    | 23                     | 10                 |
| 74081                   | 18                    | 38                     | 20                 | 73369                    | 15                    | 19                     | 4                  | 74420                   | 9                     | 17                     | 8                  |
| 74384                   | 18                    | 32                     | 14                 | 74346                    | 13                    | 28                     | 15                 | 74118                   | 12                    | 21                     | 9                  |
| 74027                   | Transferred           |                        |                    | 74360                    | 15                    | 22                     | 7                  | 74189                   | 13                    | 34                     | 21                 |
| 74319                   | 8                     | 26                     | 18                 | 74361                    | 7                     | 22                     | 15                 | 74249                   | 4                     | 23                     | 19                 |
| 74021                   | 10                    | 30                     | 20                 | 73423                    | 7                     | 21                     | 14                 | 74025                   | 17                    | 18                     | 1                  |
| 73224                   | 11                    | 26                     | 15                 | 73424                    | 13                    | 15                     | 2                  | 73204                   | 13                    | 15                     | 2                  |
| 73359                   | 13                    | 17                     | 4                  | 73461                    | 14                    | 15                     | 1                  | 73460                   | 11                    | 15                     | 4                  |
| Sums                    | 240                   | 528                    | 288                | Sums                     | 224                   | 462                    | 238                | Sums                    | 262                   | 494                    | 232                |
| Means                   | 10.91                 | 24.00                  | 13.09              | Means                    | 10.67                 | 22.00                  | 11.33              | Means                   | 11.39                 | 21.48                  | 10.09              |
| Std. Dev.               | 4.33                  | 6.18                   |                    | Std. Dev.                | 3.28                  | 5.12                   |                    | Std. Dev.               | 3.55                  | 5.62                   |                    |
| Pre/Post r = .541       |                       |                        |                    | Pre/Post r = (-).066     |                       |                        |                    | Pre/Post r = .075       |                       |                        |                    |
| N = 22                  |                       |                        |                    | N = 21                   |                       |                        |                    | N = 23                  |                       |                        |                    |

APPENDIX F

APPENDIX F-1  
BSCS GREEN VERSION HIGH SCHOOL BIOLOGY COMPREHENSIVE FINAL EXAMINATION  
POSTTEST AND FOLLOW-UP RAW SCORES OF SUBJECTS BY GROUPS  
BIOLOGY INVESTIGATION A

| Group A <sub>1</sub><br>Student No. | Post-<br>test<br>Score | Follow<br>up<br>Score | Gain<br>or<br>Loss | Group A <sub>2</sub><br>Student No. | Post-<br>test<br>Score | Follow<br>up<br>Score | Gain<br>or<br>Loss |
|-------------------------------------|------------------------|-----------------------|--------------------|-------------------------------------|------------------------|-----------------------|--------------------|
| 73192                               | 24                     | 31                    | 7                  | 73005                               | Transferred            |                       |                    |
| 73268                               | 14                     | 17                    | 3                  | 73027                               | 16                     | 18                    | 2                  |
| 73109                               | 14                     | 13                    | -1                 | 73043                               | 25                     | 20                    | -5                 |
| 73260                               | Transferred            |                       |                    | 73060                               | 25                     | 17                    | -8                 |
| 73335                               | 15                     | 28                    | 13                 | 73069                               | 19                     | 22                    | 3                  |
| 74149                               | 29                     | 26                    | -3                 | 74095                               | 31                     | 32                    | 1                  |
| 73071                               | 20                     | 17                    | -3                 | 73127                               | 18                     | 17                    | -1                 |
| 73093                               | 24                     | 27                    | 3                  | 74127                               | 33                     | 32                    | -1                 |
| 73360                               | 15                     | 13                    | -2                 | 73168                               | 18                     | 16                    | -2                 |
| 74218                               | 27                     | 23                    | -4                 | 74184                               | 21                     | 19                    | -2                 |
| 73209                               | 22                     | 23                    | 1                  | 73214                               | 16                     | 16                    | 0                  |
| 74209                               | 34                     | 29                    | -5                 | 74200                               | 34                     | 37                    | 3                  |
| 73066                               | 14                     | 16                    | 2                  | 73229                               | 19                     | 9                     | -10                |
| 74016                               | 22                     | 14                    | -8                 | 74222                               | 21                     | 26                    | 5                  |
| 74012                               | 31                     | 18                    | -13                | 74237                               | 27                     | 18                    | -9                 |
| 74316                               | 34                     | 26                    | -8                 | 74243                               | 36                     | 31                    | -5                 |
| 73011                               | Transferred            |                       |                    | 73273                               | 16                     | 26                    | 10                 |
| 74139                               | 23                     | 24                    | 1                  | 74286                               | 28                     | 23                    | -5                 |
| 74262                               | 25                     | 30                    | 5                  | 74298                               | 24                     | 25                    | 1                  |
| 73404                               | 21                     | 27                    | 6                  | 73347                               | 17                     | 24                    | 7                  |
| 73468                               | 20                     | 28                    | 8                  | 73397                               | 20                     | 21                    | 1                  |
| 73378                               | 18                     | 13                    | -5                 | 73399                               | 20                     | 29                    | 9                  |
| 73110                               | 21                     | 28                    | 7                  | 73403                               | 19                     | 16                    | -3                 |
| 73065                               | 22                     | 27                    | 5                  | 73411                               | 23                     | 19                    | -4                 |
| Sums                                | 489                    | 498                   | 9                  | Sums                                | 526                    | 513                   | -13                |
| Means                               | 22.23                  | 22.64                 | .41                | Means                               | 22.87                  | 22.30                 | .57                |
| Std. Dev.                           | 6.07                   | 6.23                  |                    | Std. Dev.                           | 6.07                   | 6.68                  |                    |
| Post/Follow-Up                      | r = .4826              |                       |                    | Post/Follow-Up                      | r = .6525              |                       |                    |
| N = 22                              |                        |                       |                    | N = 23                              |                        |                       |                    |
| Group A <sub>1</sub><br>Student No. | Post-<br>test<br>Score | Follow<br>up<br>Score | Gain<br>or<br>Loss | Group A <sub>2</sub><br>Student No. | Post-<br>test<br>Score | Follow<br>up<br>Score | Gain<br>or<br>Loss |
| 73192                               | 24                     | 31                    | 7                  | 73265                               | 21                     | 23                    | 2                  |
| 73268                               | 14                     | 17                    | 3                  | 73379                               | 17                     | 19                    | 2                  |
| 73109                               | 14                     | 13                    | -1                 | 73347                               | Transferred            |                       |                    |
| 73260                               | Transferred            |                       |                    | 73177                               | 14                     | 21                    | 7                  |
| 73335                               | 15                     | 28                    | 13                 | 73449                               | Transferred            |                       |                    |
| 74149                               | 29                     | 26                    | -3                 | 74033                               | 33                     | 34                    | 1                  |
| 73071                               | 20                     | 17                    | -3                 | 73067                               | 19                     | 19                    | 0                  |
| 73093                               | 24                     | 27                    | 3                  | 73099                               | 20                     | 19                    | -1                 |
| 73360                               | 15                     | 13                    | -2                 | 73107                               | 23                     | 20                    | -3                 |
| 74218                               | 27                     | 23                    | -4                 | 74413                               | 33                     | 21                    | -12                |
| 73209                               | 22                     | 23                    | 1                  | 73121                               | Transferred            |                       |                    |
| 74209                               | 34                     | 29                    | -5                 | 74433                               | 22                     | 20                    | -2                 |
| 73066                               | 14                     | 16                    | 2                  | 73343                               | 27                     | 22                    | -5                 |
| 74016                               | 22                     | 14                    | -8                 | 74137                               | Transferred            |                       |                    |
| 74012                               | 31                     | 18                    | -13                | 74116                               | 37                     | 36                    | -1                 |
| 74316                               | 34                     | 26                    | -8                 | 74355                               | 28                     | 27                    | -1                 |
| 73011                               | Transferred            |                       |                    | 73148                               | 21                     | 14                    | -7                 |
| 74139                               | 23                     | 24                    | 1                  | 74208                               | Transferred            |                       |                    |
| 74262                               | 25                     | 30                    | 5                  | 74336                               | 31                     | 29                    | -2                 |
| 73404                               | 21                     | 27                    | 6                  | 73450                               | 35                     | 31                    | -4                 |
| 73468                               | 20                     | 28                    | 8                  | 73178                               | 27                     | 15                    | -12                |
| 73378                               | 18                     | 13                    | -5                 | 73119                               | 22                     | 24                    | 2                  |
| 73110                               | 21                     | 28                    | 7                  | 73199                               | 27                     | 24                    | -3                 |
| 73065                               | 22                     | 27                    | 5                  | 73448                               | 25                     | 20                    | -5                 |
| Sums                                | 489                    | 498                   | 9                  | Sums                                | 482                    | 438                   | -44                |
| Means                               | 22.23                  | 22.64                 | .41                | Means                               | 25.37                  | 23.05                 | -2.32              |
| Std. Dev.                           | 6.07                   | 6.23                  |                    | Std. Dev.                           | 6.35                   | 5.95                  |                    |
| Post/Follow-Up                      | r = .4826              |                       |                    | Post/Follow-Up                      | r = .7139              |                       |                    |
| N = 22                              |                        |                       |                    | N = 19                              |                        |                       |                    |



APPENDIX F-2  
BSCS GREEN VERSION HIGH SCHOOL BIOLOGY COMPREHENSIVE FINAL EXAMINATION  
POSTTEST AND FOLLOW-UP RAW SCORES OF SUBJECTS BY GROUPS  
BIOLOGY INVESTIGATION B

| Group B1<br>Student No. | Post-<br>test<br>Score | Follow<br>up<br>Score | Gain<br>or<br>Loss | Group B9<br>Student No. | Post-<br>test<br>Score | Follow<br>up<br>Score | Gain<br>or<br>Loss | Group B2<br>Student No. | Post-<br>test<br>Score | Follow<br>up<br>Score | Gain<br>or<br>Loss |
|-------------------------|------------------------|-----------------------|--------------------|-------------------------|------------------------|-----------------------|--------------------|-------------------------|------------------------|-----------------------|--------------------|
| 74443                   | 27                     | 24                    | - 3                | 74014                   | 28                     | 24                    | - 4                | 74145                   | 32                     | 28                    | - 4                |
| 74384                   | 30                     | 33                    | 3                  | 74023                   | 20                     | 17                    | - 3                | 74118                   | 30                     | 22                    | - 8                |
| 74399                   | 30                     | 30                    | 0                  | 74093                   | 37                     | 29                    | - 8                | 74257                   | 33                     | 34                    | 1                  |
| 74319                   | 19                     | 25                    | 6                  | 74115                   | 28                     | 25                    | - 3                | 74249                   | 19                     | 20                    | 1                  |
| 73138                   | 16                     | 14                    | - 2                | 73132                   | Transferred            |                       |                    | 73305                   | 17                     | 14                    | - 3                |
| 74264                   | 31                     | 24                    | - 7                | 73146                   | 16                     | 16                    | 0                  | 74132                   | Transferred            |                       |                    |
| 74027                   | Transferred            |                       |                    | 74169                   | 22                     | 22                    | 0                  | 74189                   | Transferred            |                       |                    |
| 74392                   | 31                     | 22                    | - 9                | 74223                   | 32                     | 25                    | - 7                | 74430                   | 19                     | 21                    | 2                  |
| 73412                   | 13                     | 14                    | 1                  | 73251                   | 17                     | 15                    | - 2                | 74284                   | 19                     | 21                    | 2                  |
| 74136                   | Transferred            |                       |                    | 74239                   | 24                     | 22                    | - 2                | 74407                   | 26                     | 23                    | - 3                |
| 74081                   | 38                     | 33                    | - 5                | 74248                   | 27                     | 27                    | 0                  | 74244                   | 26                     | 28                    | 2                  |
| 74330                   | Transferred            |                       |                    | 74255                   | 32                     | 28                    | - 4                | 73377                   | 22                     | 16                    | - 6                |
| 73308                   | 20                     | 23                    | 3                  | 73299                   | 26                     | 27                    | 1                  | 73196                   | 22                     | 22                    | 0                  |
| 74044                   | 27                     | 26                    | - 1                | 74280                   | 19                     | 23                    | 4                  | 74025                   | 19                     | 22                    | 3                  |
| 73056                   | 24                     | 21                    | - 3                | 72315                   | Transferred            |                       |                    | 73050                   | 17                     | 21                    | 4                  |
| 73224                   | 24                     | 25                    | 1                  | 74325                   | 20                     | 16                    | - 4                | 73204                   | Transferred            |                       |                    |
| 73359                   | 22                     | 27                    | 5                  | 74348                   | 20                     | 11                    | - 9                | 73460                   | 21                     | 19                    | - 2                |
| 74021                   | 23                     | 21                    | - 2                | 74362                   | 22                     | 20                    | - 2                | 74420                   | 26                     | 28                    | 2                  |
| 74180                   | 35                     | 29                    | - 6                | 74387                   | 27                     | 28                    | 1                  | 74381                   | 28                     | 31                    | 3                  |
| 74064                   | 23                     | 18                    | - 5                | 74411                   | Transferred            |                       |                    | 74326                   | Transferred            |                       |                    |
| 73365                   | 22                     | 28                    | 6                  | 73441                   | 15                     | 15                    | 0                  | 73400                   | 34                     | 33                    | - 1                |
| 74141                   | 25                     | 24                    | - 1                | 74436                   | 22                     | 11                    | -11                | 74178                   | 24                     | 24                    | 0                  |
| 74303                   | 22                     | 18                    | - 4                | 74438                   | 24                     | 18                    | - 6                | 74029                   | 25                     | 22                    | - 3                |
| 73063                   | 26                     | 15                    | -11                | 73467                   | 19                     | 12                    | - 7                | 73188                   | 19                     | 17                    | - 2                |
| Sums                    | 528                    | 494                   | -34                | Sums                    | 497                    | 431                   | -66                | Sums                    | 478                    | 466                   | -12                |
| Means                   | 25.14                  | 23.52                 | - 1.62             | Means                   | 23.66                  | 20.52                 | - 3.14             | Means                   | 23.90                  | 23.30                 | - .60              |
| Std. Dev.               | 6.01                   | 5.59                  |                    | Std. Dev.               | 5.71                   | 5.94                  |                    | Std. Dev.               | 5.38                   | 5.46                  |                    |
| Post/Follow-Up          | r = .6731              |                       |                    | Post/Follow-Up          | r = .7881              |                       |                    | Post/Follow-Up          | r = .8237              |                       |                    |
| N = 21                  |                        |                       |                    | N = 21                  |                        |                       |                    | N = 20                  |                        |                       |                    |

APPENDIX G

APPENDIX C-1  
HOWELL GEOMETRY TEST POSTTEST AND FOLLOW-UP TEST RAW SCORES OF SUBJECTS BY GROUPS  
GEOMETRY INVESTIGATION A

| Group A <sub>1</sub><br>Student No. | Post- Follow Gain |       |       | Group A <sub>10</sub><br>Student No. | Post- Follow Gain |       |       | Group A <sub>2</sub><br>Student No. | Post- Follow Gain |       |       |
|-------------------------------------|-------------------|-------|-------|--------------------------------------|-------------------|-------|-------|-------------------------------------|-------------------|-------|-------|
|                                     | test              | up    | or    |                                      | test              | up    | or    |                                     | test              | up    | or    |
| 73209                               | 34                | 22    | -12   | 73015                                | 24                | 17    | -7    | 73121                               | Transferred       |       |       |
| 73192                               | 29                | 23    | -6    | 73031                                | 19                | 14    | -5    | 73265                               | 32                | 31    | -1    |
| 73071                               | 15                | 17    | 2     | 73044                                | 31                | 24    | -7    | 73067                               | 20                | 22    | 2     |
| 73065                               | 13                | 22    | 9     | 73059                                | 26                | 19    | -7    | 73448                               | 23                | 26    | 3     |
| 74149                               | 27                | 24    | -3    | 74102                                | 20                | 22    | 2     | 74033                               | 30                | 23    | -7    |
| 74139                               | 25                | 19    | -6    | 74130                                | 27                | 27    | 0     | 74208                               | Transferred       |       |       |
| 73011                               | Transferred       |       |       | 73151                                | 24                | 10    | -14   | 73148                               | 22                | 18    | -4    |
| 73335                               | 33                | 21    | -12   | 73155                                | 24                | 21    | -3    | 73449                               | Transferred       |       |       |
| 73404                               | 25                | 29    | 4     | 73161                                | 18                | 31    | 13    | 73450                               | 36                | 22    | -14   |
| 73360                               | 17                | 20    | 3     | 73181                                | 19                | 21    | 2     | 73170                               | 20                | 15    | -5    |
| 74262                               | 30                | 22    | -8    | 74173                                | 30                | 23    | -7    | 74336                               | 27                | 19    | -8    |
| 74316                               | 31                | 20    | -11   | 74175                                | 35                | 29    | -6    | 74355                               | 32                | 27    | -5    |
| 73260                               | Transferred       |       |       | 73200                                | 14                | 10    | -4    | 73177                               | 21                | 13    | -8    |
| 74218                               | 24                | 19    | -5    | 74207                                | 32                | 18    | -14   | 74413                               | 28                | 15    | -13   |
| 73109                               | 19                | 10    | -9    | 73233                                | 26                | 20    | -6    | 73347                               | Transferred       |       |       |
| 74209                               | 33                | 33    | 0     | 74214                                | 26                | 25    | -1    | 74433                               | 26                | 16    | -10   |
| 73268                               | Transferred       |       |       | 73264                                | 21                | 13    | -8    | 73379                               | 14                | 13    | -1    |
| 73468                               | 29                | 22    | -7    | 73286                                | 23                | 24    | 1     | 73178                               | 26                | 23    | -3    |
| 73093                               | 30                | 27    | -3    | 73307                                | 22                | 22    | 0     | 73099                               | 18                | 13    | -5    |
| 73066                               | 23                | 20    | -3    | 73339                                | Transferred       |       |       | 73343                               | 20                | 17    | -3    |
| 73378                               | 21                | 18    | -3    | 73346                                | Transferred       |       |       | 73119                               | 22                | 27    | 5     |
| 73110                               | 39                | 28    | -11   | 73375                                | 35                | 28    | -7    | 73199                               | 28                | 29    | 1     |
| 74012                               | 29                | 23    | -6    | 74372                                | 30                | 20    | -10   | 74116                               | 28                | 18    | -10   |
| 74016                               | 25                | 21    | -4    | 73426                                | 27                | 20    | -7    | 74137                               | Transferred       |       |       |
| Sums                                | 551               | 460   | -91   | Sums                                 | 553               | 458   | -95   | Sums                                | 473               | 387   | -86   |
| Means                               | 26.23             | 21.90 | -4.33 | Means                                | 25.14             | 20.82 | -4.32 | Means                               | 24.89             | 20.37 | -4.52 |
| Std. Dev.                           | 6.62              | 4.76  |       | Std. Dev.                            | 5.14              | 5.67  |       | Std. Dev.                           | 5.58              | 5.73  |       |
| Post/Follow-up                      | r = .5591         |       |       | Post/Follow-up                       | r = .4389         |       |       | Post/Follow-up                      | r = .5631         |       |       |
| N = 21                              |                   |       |       | N = 22                               |                   |       |       | N = 19                              |                   |       |       |

APPENDIX G-2  
HOWELL GEOMETRY TEST POSTTEST AND FOLLOW-UP TEST RAW SCORES OF SUBJECTS BY GROUPS  
GEOMETRY INVESTIGATION B

| Group B1<br>Student No. | Post- Follow Gain |       |        | Group B10<br>Student No. | Post- Follow Gain |       |        | Group B2<br>Student No. | Post- Follow Gain |       |        |
|-------------------------|-------------------|-------|--------|--------------------------|-------------------|-------|--------|-------------------------|-------------------|-------|--------|
|                         | test              | up    | or     |                          | test              | up    | or     |                         | test              | up    | or     |
| Score                   | Score             | Score | Loss   | Score                    | Score             | Score | Loss   | Score                   | Score             | Score | Loss   |
| 73056                   | 21                | 24    | 3      | 73024                    | 14                | 16    | 2      | 73050                   | 14                | 16    | 2      |
| 74264                   | 25                | 28    | 3      | 74075                    | Transferred       |       |        | 74257                   | 25                | 27    | 2      |
| 73138                   | 18                | 14    | - 4    | 73512                    | Transferred       |       |        | 74132                   | Transferred       |       |        |
| 73063                   | 23                | 17    | - 6    | 73083                    | 19                | 15    | - 4    | 73188                   | 16                | 17    | 1      |
| 73308                   | 13                | 11    | - 2    | 73126                    | 23                | 18    | - 5    | 73196                   | 16                | 14    | - 2    |
| 74443                   | 26                | 16    | -10    | 74140                    | 32                | 30    | - 2    | 74145                   | 24                | 24    | 0      |
| 74064                   | 22                | 18    | - 4    | 73150                    | 21                | 18    | - 3    | 74326                   | Transferred       |       |        |
| 74136                   | Transferred       |       |        | 73175                    | 27                | 18    | - 9    | 74407                   | 19                | 23    | 4      |
| 74180                   | 33                | 31    | - 2    | 73206                    | 14                | 15    | 1      | 74381                   | 27                | 22    | - 5    |
| 74399                   | 23                | 19    | - 4    | 73511                    | 18                | 18    | 0      | 73305                   | 14                | 17    | 3      |
| 73365                   | 26                | 25    | - 1    | 73241                    | 26                | 22    | - 4    | 73400                   | 26                | 19    | - 7    |
| 74330                   | Transferred       |       |        | 73250                    | 25                | 17    | - 8    | 73377                   | 19                | 23    | 4      |
| 74392                   | 29                | 19    | -10    | 74246                    | 27                | 26    | - 1    | 74430                   | 20                | 20    | 0      |
| 74141                   | 25                | 19    | - 6    | 74252                    | 29                | 23    | - 6    | 74178                   | 29                | 19    | -10    |
| 74303                   | 14                | 9     | - 5    | 74301                    | 22                | 18    | - 4    | 74029                   | 27                | 24    | - 3    |
| 73412                   | 19                | 12    | - 7    | 73336                    | Transferred       |       |        | 74284                   | Transferred       |       |        |
| 74044                   | 18                | 25    | 7      | 74340                    | 23                | 21    | - 2    | 74244                   | 23                | 22    | - 1    |
| 74081                   | 38                | 27    | -11    | 73369                    | Transferred       |       |        | 74420                   | 17                | 12    | - 5    |
| 74384                   | 32                | 31    | - 1    | 74346                    | 28                | 23    | - 5    | 74118                   | 21                | 21    | 0      |
| 74027                   | Transferred       |       |        | 74360                    | 22                | 21    | - 1    | 74189                   | 34                | 22    | -12    |
| 74319                   | 26                | 19    | - 7    | 74361                    | 22                | 13    | - 9    | 74249                   | 23                | 14    | - 9    |
| 74021                   | 30                | 21    | - 9    | 73423                    | 21                | 22    | 1      | 74025                   | 18                | 17    | - 1    |
| 73224                   | 26                | 12    | -14    | 73424                    | 15                | 17    | 2      | 73204                   | Transferred       |       |        |
| 73359                   | 17                | 14    | - 3    | 73461                    | 15                | 9     | - 6    | 73460                   | 15                | 20    | 5      |
| Sums                    | 504               | 411   | -93    | Sums                     | 443               | 380   | -63    | Sums                    | 427               | 393   | -34    |
| Means                   | 24.00             | 19.57 | - 4.43 | Means                    | 22.15             | 19.00 | - 3.15 | Means                   | 21.35             | 19.65 | - 1.70 |
| Std. Dev.               | 6.33              | 6.53  |        | Std. Dev.                | 5.20              | 4.69  |        | Std. Dev.               | 5.52              | 3.91  |        |
| Post/Follow-up          | r = .6891         |       |        | Post/Follow-up           | r = .7612         |       |        | Post/Follow-up          | r = .5035         |       |        |
| N = 21                  |                   |       |        | N = 20                   |                   |       |        | N = 20                  |                   |       |        |